

# *Chapter 2*

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**Alternatives  
Considered**

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## 2.0 ALTERNATIVES CONSIDERED

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This chapter describes the No-Build Alternative and the five Build Alternatives evaluated in this Final Environmental Impact Statement (FEIS). It also describes other alternatives considered but not retained for detailed evaluation. Chapter 2 is divided into the following four major sections:

- Study Chronology, beginning on page 2-1, which lists the key events in the study process between 1990 and 2005;
- Selection of the Blowing Rock Bypass Alternatives, beginning on page 2-8, which describes in detail the bypass decision-making process between 1990 and 1999;
- Alternatives to a Four-Lane Project (including the No-Build Alternative), beginning on page 2-39, which describes the assessment of potential alternatives to a four-lane project and the finding that they would not meet the project's purpose and need; and
- Description of Build Alternatives, beginning on page 2-61, which describes the characteristics of the build alternatives evaluated in detail in Chapter 4.

### 2.1 Study Chronology

This section lists and briefly describes the key events in the US 321 study from 1989 to 2005. Its purpose is to provide the reader with an overview of the study process. Although the key events in the bypass alternatives studies are listed, a detailed discussion of the bypass studies conducted, the decisions made, and the reasons for those decisions are presented in Section 2.2. The US 321 study process consisted of the following stages or phases:

- 1989 to 1994 preparation of an Environmental Assessment (EA) that assessed US 321 improvements between NC 168 at Patterson to US 221 in the Town of Blowing Rock and a Finding of No Significant Impact (FONSI) that assessed US 321 improvements between NC 168 at Patterson to SR 1500 (Blackberry Road) south of the Town of Blowing Rock. The study concluded that the portion of the project from Blackberry Road to US 221 in Blowing Rock should be re-examined as a part of an Environmental Impact Statement.
- 1995 to 1997 Blowing Rock bypass studies that examined (with the help of a Citizens Advisory Committee) numerous options for a bypass around the Town of Blowing Rock. Four bypass corridor alternatives were selected for evaluation in an Environmental Impact Statement.
- 1998 to 1999 studies that revisited the decisions made in the 1995 to 1997 bypass studies and examined the use of landscaping as a means for mitigating the impacts of widening existing US 321. The number of bypass corridor alternatives to be evaluated in an Environmental Impact Statement (EIS) was narrowed from four to two.
- 1999 to 2005 preparation and release of the Draft Environmental Impact Statement (DEIS), pre-hearing workshops and a public hearing, selection of a preferred alternative, negotiation of mitigation agreements, and preparation of the Final Environmental Impact Statement (FEIS).

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### **2.1.1 1990 to 1994 Environmental Assessment and Finding of No Significant Impact**

The US 321 improvements study began in late 1989 as strictly a widening project from NC 268 at Patterson to Possum Hollow Road in Blowing Rock (see Figure 1-1). The EA approved in August 1993 evaluated a preferred Widening Alternative. Potential bypass alternatives were examined in the EA, but were not considered reasonable alternatives for implementation (see Figure 2-1), although a single “most reasonable” bypass alternative was compared with the Widening Alternative (see Figure 2-2). The current Bypass Alternative 1A is a refined version of this alternative.

Following a public hearing, a FONSI was released in September 1994 for widening US 321 between NC 268 and Blackberry Road stated that an EIS would be prepared for US 321 improvements from Blackberry Road to US 221 and Possum Hollow Road. Consideration of a Blowing Rock bypass would be included in the EIS.

### **2.1.2 1995 to 1997 Blowing Rock Bypass Studies**

A new study of potential bypass alternatives began in 1995. On July 12, 1995, the first meeting of a project Citizens Advisory Committee was held to introduce the bypass alternatives study and to discuss key issues associated with the study. (See Section 7.3.1 of Chapter 7 for a description of the membership of the Citizens Advisory Committee.)

In August 1995, a scoping letter was distributed to Federal and state environmental resource and regulatory agencies to solicit comments on the EIS study, initiate coordination for the project, and provide notice of an interagency scoping meeting, to be held on February 1, 1996.

On August 29, 1995, a Citizens Informational Workshop was held in Blowing Rock to solicit comments on potential alternatives and environmental impact issues. A land suitability map showing community, cultural, and natural features in the project area was displayed. The desire for an alternative that crossed the Blue Ridge Parkway, including a tunnel crossing, was expressed.

Conceptual design criteria specifying grade and curve requirements and a roadway typical section were prepared. Potential bypass alternatives were developed, including four alternatives proposed by the Concerned Citizens of Blowing Rock. None of the alternatives proposed crossed the Blue Ridge Parkway.

A second Citizens Advisory Committee meeting was held on November 11, 1995 to review citizen and agency comments and the potential bypass alternatives. On February 1, 1996, an Interagency/Steering Committee meeting was held. Traffic forecasts for the potential bypass alternatives were presented. A third Citizens Advisory Committee meeting was held on March 27, 1996 to review the traffic forecasts, levels of service, and design criteria for the potential bypass alternatives. The feasibility of a Parkway crossing also was discussed.

Functional designs for ten bypass alternatives were prepared. The alternatives recommended by the Concerned Citizens of Blowing Rock were refined to form four alternatives. A fifth alternative was a refined version of the bypass alternative presented as the “most reasonable” bypass alternative in the 1993 Environmental Assessment. Five additional alternatives were developed by the study team to reflect alternate ways for passing through the Blowing Rock

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**Figure 2-1. 1993 Blowing Rock Bypass Alternatives**

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**Figure 2-2. 1993 “Most Reasonable” Blowing Rock Bypass Alternative**

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Assembly Grounds. The refinements to the Concerned Citizens of Blowing Rock's alternatives allowed the alternatives to more closely follow the existing terrain, reducing the amount of potential earth work and cost.

A fourth Citizens Advisory Committee meeting was held on July 31, 1996 to discuss the ten bypass alternatives and their potential traffic, social, natural resource, and visual impacts. Committee members were asked to list the criteria they considered important when selecting reasonable bypass alternatives and to identify the alternatives they believed should be compared to the Widening Alternative in a DEIS. The selection criteria identified most by committee members, in order, were community impact, safety, efficiency of traffic movement, and cost. The North Carolina Department of Transportation (NCDOT) re-affirmed its decision not to pursue bypass alternatives that cross the Blue Ridge Parkway.

A second Citizens Informational Workshop was held on August 1, 1996 to present the ten bypass alternatives and their potential impacts to the public. Opposition to the bypass alternatives developed by the study team was universal. Citizens living in Caldwell County and in the rural areas in Watauga County generally supported the Widening Alternative. Most others indicated that an alternative that completely bypassed Blowing Rock was the only reasonable option.

At the urging of the Blowing Rock Town Council, and the Concerned Citizens of Blowing Rock the NCDOT decided to examine several new alternatives proposed by the Concerned Citizens of Blowing Rock. Seven alternatives were ultimately developed. The Concerned Citizens provided maps showing its preferred bypass locations and design parameters. The study team met with representatives of the Concerned Citizens prior to completing its designs to affirm that the designs met their expectations. Several alternatives included a tunnel under the Blue Ridge Parkway. The only expectation not met was tunnel length. The Concerned Citizens wanted a tunnel less than 800 feet.

A second Interagency/Steering Committee Meeting was held on December 17, 1996. The 10 original alternatives and the seven additional alternatives were presented along with an assessment of each. A request was made that the assessment be restructured and mailed to members of the Interagency/Steering Committee. Thus, a questionnaire was developed that presented the advantages and disadvantages of the alternatives and asked for preferences. Copies were sent to members of the Citizens Advisory Committee and representatives of various cultural and natural resource agencies. Responses to the questionnaires were used to help select those bypass alternatives that would be compared to the Widening Alternative in the DEIS.

In 1997, the NCDOT selected four bypass alternatives to be evaluated in detail in the DEIS, which were designated Bypass Alternatives 1, 2, 3, and 4. Each of the four alternatives in combination with the Widening Alternative appeared to be a set of alternatives that best represent all the differing issues and concerns associated with the US 321 improvements project.

The decision to pursue the four bypass alternatives and the Widening Alternative was presented for discussion at a fifth meeting of the Citizens Advisory Committee on June 24, 1997. Blowing Rock and other local officials were invited to the meeting, and numerous citizens observed the meeting. The Blowing Rock Town Council passed a resolution on October 20, 1997 saying that all five alternatives were "unacceptable in addressing the Town's transportation needs." They suggested no other alternatives.

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### 2.1.3 1998 to 1999 Studies

In 1998, the NCDOT conducted a geotechnical investigation of the Widening Alternative and four bypass alternatives. This investigation provided slope recommendations for the preliminary designs presented in Appendix D.

An Origin and Destination Study (O&D) was conducted in September 1998 to determine the amount of traffic going through Blowing Rock without stopping. On a single day, a random sample of drivers was stopped at two locations on US 321, just south of the Blue Ridge Parkway and in the Blackberry Road area. Drivers were asked where their trip started and where it would end. They were asked the purpose of their trip. In addition, traffic counts were taken that day at three locations on US 321: at the Blowing Rock Town Limits, just south of Green Hill Road, between the intersections of US 321 Business and Sunset Drive, and in the Aho Road area north of the Blue Ridge Parkway.

There were 5,000 through trips passing through Blowing Rock on the day of the survey. These trips included 4,400 passenger vehicles, 300 medium-duty trucks and buses, and 275 heavy trucks. The origins of the through trips were as follows:

- 34.5 percent began their trip in Watauga County and its principle urban area, Boone;
- 29.2 percent began their trip in Caldwell County and its principle urban area, Lenoir; and
- 22.9 percent began their trip in one of the counties whose borders abut Watauga and Caldwell counties.

Thus, 87 percent of the through trips originated in Caldwell, Watauga, and the surrounding counties. There were few long distance trips passing through the project area. In addition, nearly 75 percent were trips between home and work.

Of the rest of the through trips: 7.9 percent originated in Tennessee, Virginia, or other North Carolina counties along US 321, 4.1 percent began their trip in other locations in North Carolina, and 1.5 began their trip in states other than North Carolina, Virginia, Tennessee, or South Carolina.

A video was prepared to present the results of the geotechnical and O&D studies and the NCDOT's concerns related to the bypass alternatives. The video proposed that project studies focus on a widening alternative that included landscaping and other amenities. This presentation was shown to local officials and the Citizens Advisory Committee members on March 8, 1999. Members of the public also attended.

The NCDOT asked for comments on the presentation to be submitted by May 10, 1999. Nearly 200 comments were received. About half of the respondents favored the Widening Alternative, while the other half favored Bypass Alternative 4.

In a July 20, 1999 letter to various local officials and the Citizens Advisory Committee, the NCDOT announced that it would evaluate the Widening Alternative, Bypass Alternative 1 and Bypass Alternative 4 in the Environmental Impact Statement. Bypass Alternatives 2 and 3 were eliminated from further consideration because of impacts to the Blowing Rock Assembly Grounds and lack of public support. In addition, they both required extensive cuts into the existing terrain that would result in large amounts of wasted rock and earth. Disposal of this excess material would be difficult.

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This decision to eliminate Bypass Alternatives 2 and 3 from further consideration and to carry forward the Widening Alternative and Bypass Alternative 1 was affirmed at a January 18, 2001 meeting between the NCDOT and state and federal environmental resource and regulatory agencies. Representatives of the Federal Highway Administration (FHWA) also participated in the meeting. Although the agencies did not agree that Bypass Alternative 4 should be retained for further study (because of its natural resource, social, and visual impacts), the NCDOT carried it forward based on public support.

#### **2.1.4 2000 to 2005 DEIS Preparation, Public Hearings, Selection of a Preferred Alternative, and Negotiation of Mitigation Agreements**

##### ***DEIS Preparation and Public Hearings***

After the selection of the alternatives to evaluate in detail in the DEIS in 1999 and the affirmation of that decision in 2001, the DEIS was prepared. The DEIS was signed on June 3, 2002 and released for public and environmental resource and regulatory agency review. Pre-Hearing Open House Workshops were held on August 19, 20, and 22, 2002. The public was invited to meet one-on-one with the study team at these open house sessions and discuss the findings of the DEIS. The public hearing was held on August 26, 2002. More detail about these open houses and the hearing is found in Sections 7.6 and 7.7 in Chapter 7. Comments submitted by the public and environmental resource and regulatory agencies and associated responses are presented in Sections 7.8 and 7.9 of Chapter 7.

##### ***Selection of the Preferred Alternative***

On January 15, 2003, the NCDOT met with state and federal environmental resource and regulatory agencies and identified (majority, not consensus) the Widening Alternative as the Least Environmentally Damaging Practicable Alternative (LEDPA) for US 321 improvements in Blowing Rock (Project Merger Team Concurrence Point 3 Meeting). A description of third meeting is presented in Section 7.10.1 of Chapter 7. The concurrence form associated with this agreement is presented in Appendix F.

##### ***Impact Mitigation Agreements***

The NCDOT met with the state and federal environmental resource and regulatory agencies on April 20, 2004 and agreed on the proposed major drainage structures and water resource avoidance and minimization efforts incorporated into the Preferred Alternative design (Project Merger Team Concurrence Point 2a and 4a Meeting). The concurrence form associated with this agreement is presented in Appendix F.

NCDOT representatives met with the Town Council of Blowing Rock on May 16, 2003, June 12, 2003, July 10, 2003, and October 7, 2003 to reach an agreement on a strategy for mitigating the impact of the Widening (Preferred) Alternative on the Town of Blowing Rock. The resulting Memorandum of Understanding was adopted by the North Carolina Board of Transportation on October 7, 2004, adopted by the Town Board of Blowing Rock on October 12, 2004 and executed by the NCDOT on October 7, 2004. The Memorandum of Understanding is reproduced in Appendix G.

The State Historic Preservation Officer (October 25, 2004), the NCDOT (November 4, 2004), and the US Army Corps of Engineers (USACE) (November 15, 2004) signed a Memorandum of Agreement (MOA) stipulating measures to mitigate the adverse effects the Widening (Preferred) Alternative will have on the Green Park Historic District. This MOA was developed under the terms of Section 106 of the Historic Preservation Act of 1966 (Title 36, *Code of Federal*



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*Regulations*, Part 800). Section 106 requires that federal agencies take into account the effects of their undertakings on historic properties. In this case, the federal undertaking will be the issuance of an US Army Corps of Engineers permit for excavation and fill into waters of the United States required by the Widening (Preferred) Alternative, in compliance with the Clean Water Act. In the course of developing the components of the Memorandum of Agreement, the NCDOT, the State Historic Preservation Officer's (SHPO) representatives, and the USACE representatives met on several occasions with property owners and other interested parties, including an open house on July 31, 2004. A draft of the MOA was available for public review before the agreement was finalized and signed by the NCDOT, the SHPO, and the USACE. Property owners and interested parties who so desired signed the MOA as concurring parties. The finalized Memorandum of Agreement is reproduced in Appendix G.

A description of the agency and public involvement associated with mitigation development activities is presented in Sections 7.10 to 7.12 of Chapter 7.

## **2.2 Selection of the Blowing Rock Bypass Alternatives for Evaluation in the EIS**

As described above, the two Bypass Alternative corridors (1 and 4) evaluated in Chapter 4 are the product of several studies conducted between 1990 and 1999. The character of the Widening Alternative evolved in 1999 to include a landscape plan. Such plans are now a part of all of the alternatives. The previous section listed the sequence of events that led to the selection of alternatives for evaluation. This section describes in greater detail:

- The bypass studies conducted between 1990 and 1993 in association with the preparation of an EA for widening US 321 from NC 268 to US 221;
- The bypass studies conducted between 1995 and 1997;
- A 1999 proposal to add landscape amenities to the Widening Alternative; and
- The final selection of the alternatives evaluated in Chapter 4.

### **2.2.1 1990 to 1993 Blowing Rock Bypass Corridor Studies**

An EA prepared in 1993 assessed several Blowing Rock bypass alternatives. The following is a summary of the corridor studies described in the EA, which included a general screening of a long list of location options and a comparison of the Widening Alternative and a "most reasonable" bypass alternative.

#### ***Long List Screening of Location Options***

The bypass alternatives examined fell into three general corridors: East Blowing Rock, Blackberry Valley, and Far South and East as shown in Figure 2-1. Representative routes were selected to provide a basis for comparing the basic approaches available for placing a bypass within each corridor (Figure 2-1). For the East Blowing Rock Corridor, four representative routes were examined. They are the four potential combinations of:

- Following the slope of the Blue Ridge escarpment;
- Following the top of the escarpment;

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- Crossing the Blue Ridge Parkway to return to existing US 321; and
  - Returning to existing US 321 south of the Blue Ridge Parkway.

A single alternative route following Blackberry Valley from Bailey Camp was examined for the Bailey Camp/Blackberry Valley Corridor. For the Far South and East Corridor, the tradeoffs involved with following a river valley route versus the ridge line route were examined.

The comparison of these alternatives presented in the 1993 EA concluded that all the bypass alternatives would result in substantially more impacts than the Widening Alternative. The Bailey Camp/Blackberry Valley and Far South and East routes would require a larger number of bridges and more earth moving operations. These two factors would translate into higher cost than the Widening Alternative. Among the bypass alternatives, the East Blowing Rock Corridor would cross the least amount of severe terrain. Within the corridor, the two East Blowing Rock ridge top routes would cross less severe terrain than the two East Blowing Rock ridge slope routes. The severe terrain crossed by the ridge top routes, however, would be 2.3 times that of the comparable segment of the Widening Alternative. The two East Blowing Rock ridge slope routes would cross 3.2 to 3.4 times more severe terrain than the Widening Alternative. This study concluded that the East Blowing Rock corridor would offer the least potential for environmental impact; the Bailey Camp/Blackberry Valley and Far South and East alternatives would have the greatest potential for natural resource impacts. The East Blowing Rock corridor would have the greatest potential for community impacts.

Based on these findings, The East Blowing Rock Corridor (Ridge Top/North Blowing Rock route), as shown in Figure 2-1, was determined the “most reasonable” bypass alternative. This alternative, however, would involve substantial relocations and the introduction of highway traffic to existing urban and rural communities. This alternative is similar to the current Bypass Alternative 1A.

#### ***Comparison of the Widening Alternative and “Most Reasonable” Bypass Alternative***

Further engineering studies were conducted for the “most reasonable” bypass alternative, shown in Figure 2-2. Basic construction quantities and right-of-way requirements were determined for both the “most reasonable bypass” alternative and the Widening Alternative. Cost estimates were developed based on these quantities. A comparison of the Widening Alternative and the “most reasonable” bypass alternative concluded that:

- The amount of additional right-of-way required for the bypass alternative would be approximately three times greater than with the Widening Alternative;
- Construction and right-of-way costs would be substantially more than with the Widening Alternative;
- The earth work required would be roughly 10 times that required for the Widening Alternative;
- The bypass alternative would introduce highway traffic into Blowing Rock’s Green Hill neighborhood and several other concentrations of development at the north end through which only local residential traffic now passes. It also would result in traffic traveling along part of Blowing Rock ridge lines, reducing further the availability of land with valley views for private homes and non-highway related public overlooks;

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- The potential for relocation impacts would be greater than with of the Widening Alternative; and
  - The bypass alternative also would have a greater potential for forest habitat loss and wildlife impact. Wildlife habitat would be fragmented.

In the 1993 EA, the Widening Alternative was described as the preferred alternative.

### **2.2.2 1995 to 1997 Blowing Rock Bypass Corridor Studies**

Following the 1994 approval of the FONSI, a new corridor study for potential bypass alternatives was initiated. This study and its results are documented in the *Alternatives Study Report* (Parsons Brinckerhoff Quade & Douglas, Inc., 1997). This section summarizes the key components of this work and its findings. The study area is shown in Figure 2-3.

#### ***Initial Bypass Alternatives***

The initial location selection criteria assumed that bypass alternatives would neither cross nor use lands from the Blue Ridge Parkway, would avoid concentrations of development, would avoid historic cultural resources, would follow the natural terrain as much as possible to minimize heights of cuts and fills, would meet federal and state design criteria for roads, and would consider locations suggested by citizens. All of the initial alternatives ended at Possum Hollow Road.

Ten bypass alternatives were developed initially for evaluation by the study team. They are shown in Figure 2-4 and are:

- A – Begins just south of Falcon Crest Road, proceeds in a northerly direction, turns west to climb the Blue Ridge escarpment, follows along the top of the Blue Ridge escarpment to near the Blue Ridge Parkway, then passes between the Blowing Rock Assembly Grounds Lodge and the Parkway to end at Possum Hollow Road.
- AG – Same as A, except it passes south of the Assembly Grounds lodge to end at Possum Hollow Road.
- B – Begins just north of Harrison Cemetery, proceeds in a northerly direction, turns west near the Blue Ridge Parkway, and passes between the Assembly Grounds lodge and the Parkway to end at Possum Hollow Road.
- BG – Same as B, except it passes south of the Assembly Grounds lodge to end at Possum Hollow Road.
- C – Begins near Greene Cemetery, proceeds in a northerly direction, turns west near the Blue Ridge Parkway, and passes between the Assembly Grounds lodge and the Parkway to end at Possum Hollow Road.
- CG – Same as C, except it passes south of the Assembly Grounds lodge to end at Possum Hollow Road.

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**Figure 2-3. 1995 to 1997 Project Area Map**

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**Figure 2-4. 1995 to 1997 Initial Bypass Alternatives**

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- D – Begins just south of the Watauga County line, proceeds in a northerly direction, turns west near the Blue Ridge Parkway, and passes between the Assembly Grounds lodge and the Parkway to end at Possum Hollow Road.
  - DG – Same as D, except it passes south of the Assembly Grounds lodge to end at Possum Hollow Road.
  - E – Begins just south of the Watauga County line, proceeds in a northerly direction, turns northwest just east of Green Hill, and passes between the golf course and the Assembly Grounds to end at Possum Hollow Road. This corridor is a refinement of the “most reasonable” bypass alternative presented in the 1993 EA.
  - F – This corridor is the same as E except it passes closer to the Blue Ridge Parkway as it joins Possum Hollow Road (like A through D).

The bypass alternatives considered were all east of US 321. No alternatives were considered west of Blowing Rock or suggested by project stakeholders because of unsuitable steep terrain.

#### ***Additional Bypass Alternatives***

The Blowing Rock Town Council, the Concerned Citizens of Blowing Rock, and other citizens felt that their interests were not represented by the initial bypass locations. Therefore, the study team evaluated several additional alternatives. Location criteria particularly important to the Concerned Citizens of Blowing Rock were:

- Preferably begin the bypass south of the “S” curves at the last passing section on US 321 before the south town limits of Blowing Rock;
- Definitely begin south of the final sharp curves just south of the Blowing Rock town limits;
- Avoid displacement;
- Stay out of Blowing Rock completely;
- Cross the Blue Ridge Parkway in a short tunnel or, if the road remains south of the Parkway, parallel the Parkway as closely as possible; and
- Minimize the use of grades steeper than six percent.

The alternatives developed in response to these comments and suggested criteria are shown in Figure 2-5 and are:

1. CC-AI – Begins just south of Falcon Crest Road, proceeds north across Bolick Road on a bridge, (Alternative CC-A), crosses the Blue Ridge Parkway in a tunnel, and following a route west of Thunder Mountain Road, returns to existing US 321 at Aho Road.
2. CC-BI – Begins just south of Harrison Cemetery, proceeds north along Alternative CC-B to merge quickly with Alternative CC-AI.
3. CC-CI – Begins near Greene Cemetery, and proceeds north along Alternative CC-C to merge quickly with Alternative CC-AI.
4. AJ – Begins just south of Falcon Crest Road, proceeds north across Bolick Road on fill east of Patterson, crosses the Blue Ridge Parkway in a tunnel, and following a route east of Thunder Mountain Road, returns to existing US 321 at Aho Road.

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**Figure 2-5. 1995 to 1997 Additional Bypass Alternatives**

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5. CC-AH – Begins just south of Falcon Crest Road, proceeds north to just south of the Blue Ridge Parkway, (Alternative CC-A) and turns west to parallel the Parkway until returning to existing US 321 near the New River Inn.
  6. CC-BH – Begins just south of Harrison Cemetery and proceeds north along Alternative CC-B to merge quickly with Alternative CC-AH.
  7. CC-CH – Begins near Greene Cemetery, and proceeds north along Alternative CC-C to merge quickly with Alternative CC-AH.

### ***Assessment of Potential Bypass Alternatives***

Engineering, traffic, social, cultural resource, natural resource, and visual considerations were taken into account in comparing the potential bypass alternatives. Table 2-1 and Table 2-2 summarize this comparison for the 17 bypass alternatives. All comparisons assume complete and equivalent projects. As shown in Figure 2-4 and Figure 2-5 and described in Table 2-1 and Table 2-2 can be divided into two geographic areas: south end corridor alternatives (A, CC-A, B, CC-B, C, CC-C, D, E, and F) and north end corridor alternatives (E, F, G, H, I, J). Most of the south end and north end alternatives can be mixed and matched to create additional corridor alternatives. Although the alternatives begin and end at different locations, they all follow the Blue Ridge escarpment at Green Hill near the county line. This division is illustrated in Figure 2-6 and Figure 2-7. With the exception of E and F, any south end alternative could be combined with any north end alternative.

The paragraphs below assess each of the alternatives based on the above divisions. The advantages and disadvantages of each alternative are described.

The participation of the Federal and State environmental regulatory and resource agencies and the citizens of Blowing Rock was an important component of the study. This participation is described in Chapter 7 of this document. In January 1997, the advantages and disadvantages of each alternative were distributed to the project's Citizens' Advisory Committee and Federal and State agencies in a questionnaire that asked recipients to indicate when alternatives should be evaluated in detail in the Environmental Impact Statement (EIS). The responses to this questionnaire are described below. Eighteen responses were received, ten from members of the Citizens' Advisory Committee and eight from Federal and State agencies. Of the 18 persons who responded to the questionnaire, five responded none of the alternatives were reasonable and none should be evaluated. Another three respondents did not indicate preferences for specific alternatives. The others indicated one or more preferences for particular alternatives, as indicated in the paragraphs that follow.

South End Alternatives "A", "CC-A", "B", and "CC-B". These alternatives would start south of the existing "S" curves on US 321 just south of the Falcon Crest subdivision.

- Advantages
  - Traffic. These alternatives start the farthest south. The farther south the bypass begins, the less road construction US 321 users would encounter. Also, the farther south the bypass begins, the more opportunity there is for travelers to avoid the six to eight percent grades that occur on the existing road. There is, approximately 0.6 mile of grades greater than six percent between the starting point of these alternatives and the starting point of the "C" and "CC-C" alternatives. The balance of this portion of US 321 has grades of 1.5 to 5 percent. Bypass users also would avoid seven curves with a less than 50 mph design



Table 2-1. 1997 Comparison of Potential Bypass Alternatives (Part 1)

	Widening	Potential Bypass Corridor Alternatives							
		A	AG	CC-AH	CC-AI	AJ	B	BG	CC-BH
Cost (in millions of 1996 dollars)									
Construction									
- Bypass	NA	\$51.0	\$54.1	\$92.6	\$122.0	\$114.3	\$45.5	\$49.4	\$89.1
- Widening	<u>\$24.5</u>	<u>\$0.0</u>	<u>\$0.0</u>	<u>\$0.0</u>	<u>\$0.0</u>	<u>\$0.0</u>	<u>\$2.0</u>	<u>\$2.0</u>	<u>\$1.6</u>
TOTAL	\$24.5	\$51.0	\$54.1	\$92.6	\$122.0	\$114.3	\$47.5	\$51.4	\$90.7
Right-of-Way	\$8.2	Not Prepared	Not Prepared	Not Prepared	Not Prepared	Not Prepared	Not Prepared	Not Prepared	Not Prepared
Bypass Construction Cost Components									
Excavation		\$22.9	\$23.3	\$37.3	\$25.5	\$21.9	\$20.8	\$21.7	\$36.6
Borrow		\$0.0	\$0.0	\$0.9	\$10.0	\$15.5	\$0.0	\$0.0	\$0.3
Tunnel		\$0.0	\$0.0	\$0.0	\$32.3	\$35.4	\$0.0	\$0.0	\$0.0
Bridges		\$0.2	\$0.2	\$16.2	\$16.1	\$0.5	\$0.2	\$0.2	\$16.2
Retaining Walls		\$0.0	\$1.5	\$1.4	\$2.5	\$3.2	\$0.1	\$1.6	\$1.3
Other Components		\$10.9	\$11.1	\$11.3	\$11.1	\$11.7	\$9.2	\$9.4	\$10.4
Mobilization & Misc.		\$10.3	\$10.9	\$15.4	\$14.8	\$15.8	\$9.2	\$10.0	\$14.7
Engineering & Contingencies		<u>\$6.7</u>	<u>\$7.1</u>	<u>\$10.0</u>	<u>\$9.7</u>	<u>\$10.3</u>	<u>\$6.0</u>	<u>\$6.5</u>	<u>\$9.5</u>
TOTAL		\$51.0	\$54.1	\$92.5	\$122.0	\$114.3	\$45.5	\$49.4	\$89.0
Earthwork									
Excavation (million cubic yards)	2.95	7.69	7.83	12.51	8.54	7.35	7.06	7.48	12.29
Borrow (million cubic yards)	0.00	0.00	0.00	0.26	4.00	6.78	0.00	0.00	0.00
Grades (miles)									
Greater than or equal to 6% grade (8 percent maximum)	2.10	3.70	3.50	2.60	3.30	3.40	3.30)	3.38	2.75
Greater than 7% grade (8 percent maximum)	2.10	3.70	2.60	0.10	0.10	0.00	3.20	2.44	0.00

**Table 2-1. 1997 Comparison of Potential Bypass Alternatives (Part 1)**

		Potential Bypass Corridor Alternatives							
	Widening	A	AG	CC-AH	CC-AI	AJ	B	BG	CC-BH
Horizontal Curve Exceptions to Design Criteria (number)									
Less than 45 mph posted speed	7	0	0	0	0	0	0	0	0
Less than 30 mph posted speed	3 south of Blowing Rock and 2 in Blowing Rock	0	0	0	0	0	0	0	0
2025 Average Daily Traffic									
Bypass	NA	9,750-10,500	9,750-10,500	9,750-10,500	7,150	7,150	9,750-10,500	9,750-10,500	9,750-10,500
Existing US 321 South of Blowing Rock	14,100	4,350	4,350	4,350	7,450	7,450	4,350	4,350	4,350
Existing US 321 in Blowing Rock	15,675-24,900	5,950-20,950	5,950-20,950	5,950-20,950	9,050-18,850	9,050-18,850	5,950-20,950	5,950-20,950	5,950-20,950
2025 Peak Hour Level of Service									
Bypass	NA	A	A	A	A	A	A	A	A
Existing US 321 South of Blowing Rock	A	E	E	E	E	E	E	E	E
Existing US 321 in Blowing Rock	B-D	C-D	C-D	C-D	C-D	C-D	C-D	C-D	C-D
Displacement <sup>1</sup>									
Homes	24	24	22	3	3	1	28	27	4
Mobile Homes	0	0	1	0	19	0	0	1	0
Businesses	5	0	0	1	0	0	1	0	1
Churches	0	1	1	0	0	0	0	0	0
Cemeteries	0	1	1	0	0	0	0	0	0
Other (specify)	0	0	0	0	0	0	0	0	0
TOTAL	29	26	25	4	22	1	29	28	5

**Table 2-1. 1997 Comparison of Potential Bypass Alternatives (Part 1)**

	Widening	Potential Bypass Corridor Alternatives							
		A	AG	CC-AH	CC-AI	AJ	B	BG	CC-BH
Community Impacts									
Along Existing US 321	Highway traffic remains in the communities through which it now passes but is greater than today	Highway traffic remains in the communities through which it now passes but is less than the Widening Alternative	Highway traffic remains in the communities through which it now passes but is less than the Widening Alternative	Highway traffic remains in the communities through which it now passes but is less than the Widening Alternative	Highway traffic remains in communities through which it now passes but is less than with the Widening Alternative; more traffic in Blowing Rock south of Sunset Drive than with non-tunnel bypasses	Highway traffic remains in communities through which it now passes but is less than with the Widening Alternative; more traffic in Blowing Rock south of Sunset Drive than with non-tunnel bypasses	Highway traffic remains in the communities through which it now passes but is less than the Widening Alternative	Highway traffic remains in the communities through which it now passes but is less than the Widening Alternative	Highway traffic remains in communities through which it now passes but is less than with the Widening Alternative
Along Bypass	NA	Highway traffic introduced to rural communities in Blackberry Valley, Green Hill Road, Goforth Road, and Possum Hollow Road areas; greater effects to Assembly Grounds property and activities	Highway traffic introduced to rural communities in Blackberry Valley, Green Hill Road, Goforth Road, and Possum Hollow Road areas; also to less used portion of Assembly Grounds	Highway traffic introduced to rural communities in Blackberry Valley, Green Hill Road, and Forest Lane areas; greater effects to Assembly Grounds property and activities but less than A	Highway traffic introduced to rural communities in Blackberry Valley and along Thunder Mountain Road; mobile home park at Aho Rd and US 321 displaced	Highway traffic introduced to rural communities in Blackberry Valley and along Thunder Mountain Road	Highway traffic introduced to rural communities in Blackberry Valley, Green Hill Road, Goforth Road, and Possum Hollow Road areas; greater effects to Assembly Grounds property and activities	Highway traffic introduced to rural communities in Blackberry Valley, Green Hill Road, Goforth Road, and Possum Hollow Road areas; also to less used portion of Assembly Grounds	Highway traffic introduced to rural communities in Blackberry Valley, Green Hill Road, and Forest Lane areas; greater effects to Assembly Grounds property and activities but less than B

**Table 2-1. 1997 Comparison of Potential Bypass Alternatives (Part 1)**

[illegible]

**Table 2-1. 1997 Comparison of Potential Bypass Alternatives (Part 1)**

	Widening	Potential Bypass Corridor Alternatives							
		A	AG	CC-AH	CC-AI	AJ	B	BG	CC-BH
<b>Visual</b>	Four-lane road introduced to Blowing Rock with loss of vegetation and straighter curves in the Country Club Drive/Norwood Circle area	Four-lane road introduced to rural area with large cuts and fills; road viewed from Green Hill Road area, Blue Ridge Parkway at Thunderhill and at Green Hill Road, and Assembly Grounds lodge	Four-lane road introduced to rural area with large cuts and fills; road viewed from Green Hill Road area and Blue Ridge Parkway at Thunderhill and at Green Hill Road	Four-lane road introduced to rural area with large cuts and fills; road viewed from Green Hill Road area and Blue Ridge Parkway at Thunderhill and at Green Hill Road. If trees lost, bypass in view of Parkway from Green Hill Road to US 321. Tall bridge 1,600 feet long across Bolick Road	Four-lane road introduced to rural area with large cuts and fills; road viewed from Green Hill Road area and Blue Ridge Parkway at Thunderhill; approach roads visible from Parkway. Tall bridge 1,600 feet long across Bolick Road	Four-lane road introduced to rural area with large cuts and fills; road viewed from Green Hill Road area and Blue Ridge Parkway at Thunderhill; approach roads visible from Parkway	Four-lane road introduced to rural area with large cuts and fills; road viewed from Green Hill Road area, Blue Ridge Parkway at Thunderhill and at Green Hill Road, and Assembly Grounds lodge	Four-lane road introduced to rural area with large cuts and fills; road viewed from Green Hill Road area and Blue Ridge Parkway at Thunderhill and at Green Hill Road	Four-lane road introduced to rural area with large cuts and fills; road viewed from Green Hill Road area and Blue Ridge Parkway at Thunderhill and Green Hill Road. If trees lost, bypass in view of Parkway from Green Hill Road to US 321. Tall bridge 1,600 feet long across Bolick Road

Table 2-2. 1997 Comparison of Potential Bypass Alternatives (Part 2)

	Potential Bypass Corridor Alternatives								
	CC-BI	C	CG	CC-CH	CC-CI	D	DG	E	F
<b>Cost (in millions of 1996 dollars)</b>									
<b>Construction</b>									
- Bypass	\$115.7	\$39.4	\$32.6	\$53.9	\$76.8	\$23.0	\$24.9	\$15.4	\$18.4
- Widening	<u>\$1.6</u>	<u>\$14.2</u>	<u>\$14.2</u>	<u>\$14.2</u>	<u>\$14.2</u>	<u>\$18.9</u>	<u>\$18.9</u>	<u>\$19.1</u>	<u>\$19.1</u>
TOTAL	\$117.3	\$53.6	\$46.8	\$68.1	\$91.0	\$41.9	\$43.8	\$34.5	\$37.5
Right-of-Way	Not Prepared	\$8.3	\$8.1	Not Prepared	Not Prepared	\$9.4	\$10.0	\$11.8	\$13.8
<b>Bypass Construction Cost Components</b>									
Excavation	\$24.7	\$19.0	\$12.9	\$28.0	\$16.1	\$7.6	\$8.1	\$2.4	\$4.7
Borrow	\$7.3	\$0.0	\$0.0	\$0.0	\$4.8	\$0.0	\$0.0	\$0.0	\$0.0
Tunnel	\$32.3	\$0.0	\$0.0	\$0.0	\$32.3	\$0.0	\$0.0	\$0.0	\$0.0
Bridges	\$16.1	\$0.2	\$0.2	\$0.5	\$0.4	\$1.5	\$0.1	\$0.1	\$0.3
Retaining Walls	\$2.5	\$0.0	\$1.5	\$0.0	\$1.2	\$1.0	\$2.7	\$3.7	\$2.9
Other Components	\$10.4	\$7.1	\$7.1	\$7.4	\$7.3	\$5.3	\$5.6	\$4.1	\$4.4
Mobilization & Misc.	\$13.6	\$7.9	\$6.6	\$10.9	\$8.9	\$4.7	\$5.1	\$3.1	\$3.7
Engineering & Contingencies	<u>\$8.8</u>	<u>\$5.2</u>	<u>\$4.3</u>	<u>\$7.0</u>	<u>\$5.8</u>	<u>\$3.0</u>	<u>\$3.3</u>	<u>\$2.0</u>	<u>\$2.4</u>
TOTAL	\$115.7	\$39.4	\$32.6	\$53.8	\$76.8	\$23.1	\$24.9	\$15.4	\$18.4
<b>Earthwork</b>									
Excavation (million cubic yards)	8.31	8.69	6.67	9.39	5.41	5.23	5.03	3.58	3.82
Borrow (million cubic yards)	2.93	0.00	0.00	0.00	1.92	0.00	0.00	0.00	0.00
<b>Grades in miles</b>									
Greater than or equal to 6% grade (8 percent maximum)	3.38	3.50	3.50	2.00	2.63	2.90	2.90	3.40	2.80
Greater than 7% grade (8 percent maximum)	0.00	1.40	0.70	0.00	0.00	2.60	1.70	3.10	2.80

**Table 2-2. 1997 Comparison of Potential Bypass Alternatives (Part 2)**

	Potential Bypass Corridor Alternatives								
	CC-BI	C	CG	CC-CH	CC-CI	D	DG	E	F
Less than 45 mph posted speed	0	0	0	0	0		5	7	7
Less than 30 mph posted speed	0	0	0	0	0	1	1	3	3
<b>2025 Average Daily Traffic</b>									
Bypass	7,150	9,600-10,450	9,600-10,450	9,600-10,450	7,150	8,100-8,950	8,100-8,950	10,250-10,950	10,250-10,950
Existing US 321 South of Blowing Rock	7,450	4,500	4,500	4,500	7,450	6,300	6,300	5,000	5,000
Existing US 321 in Blowing Rock	9,050-18,850	6,100-20,800	6,100-20,800	6,100-20,800	9,050-18,850	7,600-18,950	7,600-18,950	5,750-20,700	5,750-20,700
<b>2025 Peak Hour Level of Service</b>									
Bypass	A	A	A	A	A	A	A	A	A
Existing US 321 South of Blowing Rock	E	E	E	E	E	E	E	E	E
Existing US 321 in Blowing Rock	C-D	C-D	C-D	C-D	C-D	C-D	C-D	C-D	C-D
<b>Displacement<sup>1</sup></b>									
Homes	4	30	30	17	17	29	27	32	35
Mobile Homes	19	0	1	0	19	0	3	3	0
Businesses	1	0	0	1	1	0	0	0	0
Churches	0	0	0	0	0	0	0	0	0
Cemeteries	0	0	0	0	0	0	0	0	0
Other (specify)	0	0	0	0	0	0	0	0	0
TOTAL	24	30	31	18	37	29	30	35	35

Table 2-2. 1997 Comparison of Potential Bypass Alternatives (Part 2)

	Potential Bypass Corridor Alternatives								
	CC-BI	C	CG	CC-CH	CC-CI	D	DG	E	F
<b>Community Impacts</b>									
Along Existing US 321	Highway traffic remains in communities through which it now passes but is less than with the Widening Alternative; more traffic in Blowing Rock south of Sunset Drive than with non-tunnel bypasses	Highway traffic remains in the communities through which it now passes but is less than the Widening Alternative	Highway traffic remains in the communities through which it now passes but is less than the Widening Alternative	Highway traffic remains in communities through which it now passes but is less than with the Widening Alternative	Highway traffic remains in communities through which it now passes but is less than with the Widening Alternative; more traffic in Blowing Rock south of Sunset Drive than with non-tunnel bypasses	Highway traffic remains in the communities through which it now passes but is less than the Widening Alternative; however, less traffic would divert to bypass because it is longer than the existing route	Highway traffic remains in the communities through which it now passes but is less than the Widening Alternative; however, less traffic would divert to bypass because it is longer than the existing route	Highway traffic remains in the communities through which it now passes but is less than the Widening Alternative	Highway traffic remains in the communities through which it now passes but is less than the Widening Alternative
Along Bypass	Highway traffic introduced to rural communities in Blackberry Valley and along Thunder Mountain Road; mobile home park at Aho Rd and US 321 displaced	Highway traffic introduced to rural community between Blackberry Valley and Watauga County line, Green Hill Road, Goforth Road, and Possum Hollow Road areas; greater effects to Assembly Grounds property and activities	Highway traffic introduced to rural community between Blackberry Valley and Watauga County line, Green Hill Road, Goforth Road, and Possum Hollow Road areas; also to less used portion of Assembly Grounds	Highway traffic introduced to rural community between Blackberry Valley and Watauga County line and along Green Hill Road and Forest Lane area; greater effects to Assembly Grounds property and activities but less than C	Highway traffic introduced to rural communities in Blackberry Valley and along Thunder Mountain Road; mobile home park at Aho Rd and US 321 displaced	Highway traffic introduced to rural community along Green Hill Road, Goforth Road, and Possum Hollow Road area; greater effects to Assembly Grounds property and activities	Highway traffic introduced to rural community along Green Hill Road, Goforth Road, and Possum Hollow Road area; also to less used portion of Assembly Grounds	Highway traffic introduced to subdivisions along Green Hill Road, Wonderland Drive area, golf course area, and Possum Hollow Road area; less effect on Assembly Grounds property and activities	Highway traffic introduced to subdivisions along Green Hill Road, Wonderland Drive area, and Possum Hollow Road area; greater effects to Assembly Grounds property and activities
<b>Natural Resource Impacts</b>									
<b>Area of New Right-of-Way (acres)</b>									
- Along Bypass	180.0	108.7	103.7	140.5	134.8	81.5	91.4	56.8	66.7
- Along Existing US 321	13.8	55.6	55.6	55.6	55.6	79.0	79.0	80.3	80.3



**Table 2-2. 1997 Comparison of Potential Bypass Alternatives (Part 2)**

	Potential Bypass Corridor Alternatives								
	CC-BI	C	CG	CC-CH	CC-CI	D	DG	E	F
Length of New Road (miles)	4.9	3.6	3.7	3.3	3.3	2.7	2.8	2.1	2.3
<b>Wetlands</b>									
- Crossed	0	0	0	0	0	0	0	1	1
- Area Taken (acres)	0	0	0	0	0	0	0	0.69	1.11
<b>Historic Resources</b>	Regrading on property that was historic at the time	Regrading on property that was historic at the time	Regrading on property that was historic at the time	Regrading on property that was historic at the time	Regrading on property that was historic at the time	Regrading on property that was historic at the time	Regrading on property that was historic at the time	None	Minor regrading near the edge of a then historic property
<b>Visual</b>	Four-lane road introduced to rural area with large cuts and fills; road viewed from Green Hill Road area and Blue Ridge Parkway at Thunderhill; approach roads visible from Parkway. Tall bridge 1,600 feet long across Bolick Road	Four-lane road introduced to rural area with large cuts and fills; road viewed from Blue Ridge Parkway at Thunderhill and at Green Hill Road, and Assembly Grounds lodge	Four-lane road introduced to rural area with large cuts and fills; road viewed from Blue Ridge Parkway at Thunderhill and at Green Hill Road	Four-lane road introduced to rural area with large cuts and fills; road viewed Blue Ridge Parkway at Thunderhill and at Green Hill Road. If trees lost, bypass in view of Parkway from Green Hill Road to US 321	Four-lane road introduced to rural area with large cuts and fills; road viewed from Blue Ridge Parkway at Thunderhill: approach roads visible from Parkway	Four-lane road introduced to rural area with large cuts and fills; road viewed from Blue Ridge Parkway at Thunderhill and at Green Hill Road, and Assembly Grounds lodge	Four-lane road introduced to rural area with large cuts and fills; road viewed from Blue Ridge Parkway at Thunderhill and at Green Hill Road	Four-lane road introduced to neighborhoods near the golf course; road seen in distance from Blue Ridge Parkway at Thunderhill	Four-lane road introduced to neighborhoods along Green Hill Road; road seen in distance from Blue Ridge Parkway at Thunderhill and viewed from Assembly Grounds lodge

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**Figure 2-6. 1995 to 1997 South End Corridor Alternatives**

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**Figure 2-7. 1995 to 1997 North End Corridor Alternatives**

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speed just south of Blowing Rock. These curves would not be improved by the Widening Alternative.

- Community Impacts. Displacement of existing land uses would be less with the bypass alternatives that begin south of the “S” curves would relocate one or two homes and alternative “B” would relocate approximately eight homes south of Blowing Rock. Also diverting traffic from the more developed areas at Blowing Rock would reduce noise levels at homes along existing US 321.

- Disadvantages

- Cost. Starting farther south would increase total project cost. For example, the non-tunnel bypass alternatives using the “A”, “CC-A”, “B”, and “CC-B” south end alternatives would have construction costs of \$47.5 to \$92.6 million (1996 dollars). The bypass alternatives using the “D” south end alternative, which begins near the town limits of Blowing Rock, would cost \$41.9 to \$43.8 million (1996 dollars).

The farther south the bypass begins, the fewer improvements would be made to existing US 321 south of Blowing Rock. Narrow lanes, sharp curves, and steep grades would be improved by widening the existing road and starting the bypass farther north. The “A” and “CC-A” alternatives would leave 3.5 miles of existing US 321 south of Blowing Rock unimproved. The “B” and “CC-B” alternatives would leave 2.7 to 2.8 miles of existing US 321 south of Blowing Rock unimproved.

- Natural Resource Impacts. The farther south the bypass begins, the greater the loss of undisturbed wildlife habitat.
- Community Impacts. The longer bypass routes would introduce more new thoroughfare into rural communities, primarily Bailey Camp and Blackberry Valley, which now have low volumes of local traffic passing through them. These alternatives also could displace the Bailey Camp Baptist Church and cemetery or place a large fill or retaining wall adjacent to the church cemetery. Saving the church and cemetery would add approximately \$15 million (1996 dollars) to the costs of these alternatives.

The “CC-A” and “CC-B” alternatives would cross Bolick Road on a long, high-level bridge. This bridge, which would be 1,600 feet long, and would have an average height of 115 feet and a maximum height of 184 feet, would be a substantial new visual feature in the community served by Bolick Road. The bridge would add \$4.4 million to project costs (compared to the “A” and “B” alternatives that do not cross the valley).

- Historic Resource Impacts. These alternatives would pass through a property that is potentially eligible for the National Register of Historic Places (property has since lost eligibility because of modifications made by owner).

- Citizens’ Advisory Committee and Agencies Responses

There was little support among Citizens’ Advisory Committee and agency representatives for a bypass with a terminus this far south. Several members of the Citizens’ Advisory Committee were concerned about the potential impacts of these alternatives on the Bailey Camp Church and cemetery and the rural communities in the valley. Cost and natural resource impacts were concerns for almost everyone. Concern also was expressed as to

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whether truck drivers would find such a bypass preferable over the existing route. Those who indicated a preference for these alternatives considered them desirable because bypass users would avoid more of the steep grades and sharp curves on existing US 321. They suggested that impacts to the church and community could be minimized.

South End Alternatives “C” and “CC-C”. These alternatives would start north of the existing “S” curves but south of the east curves before the Town of Blowing Rock near Greene Cemetery.

- Advantages

- Cost. Construction costs for the “C” and “CC-C” alternatives would be less than for the longer “A”, “CC-A”, “B”, and “CC-B” alternatives.
- Traffic. Bypass users would avoid seven curves with less than a 50 mph design speed. These curves between Bailey Camp and Blowing Rock would be improved with the Widening Alternative. The south end alternatives would leave 1.5 miles of existing US 321 south of Blowing Rock. By widening the existing road and starting the bypass farther north.
- Natural Resource Impacts. The loss of undisturbed wildlife habitat would be less with the “C” and “CC-C” alternatives than with the “A”, “CC-A”, “B”, and “CC-B” alternatives. Approximately 60 acres of land would be cleared and grubbed below the top of the Blue Ridge escarpment with the “CC-C” alternative. The “CC-A” alternative would require 120 acres of land to be cleared and grubbed below the top of the Blue Ridge escarpment (some of that area was recently clear-cut).
- Community Impacts. Fewer miles of new thoroughfare would be introduced into rural communities than with the bypass alternatives that begin farther south. The “CC-A” alternative would introduce 3.8 miles of new road south of the Watauga-Caldwell county line. The “CC-C” alternative would introduce 1.9 miles of new road south of the Watauga-Caldwell county line.

- Disadvantages

- Traffic. Traffic on US 321 would pass through an additional 1.2 to 2.0 miles of road construction than with the “A”, “CC-A”, “B”, and “CC-B” alternatives. An additional disadvantage from the traffic perspective is that less opportunity would exist for travelers to avoid 6 to 8 percent grades on the existing road with the “C” and “CC-C” alternatives than the “A” and “CC-A” alternatives.
- Community Impacts. Approximately 14 homes south of Blowing Rock would be relocated with the “C” and “CC-C” alternatives. These relocations would occur primarily along the widening portion of the alternatives. Additionally, most noise impacts associated with the Widening Alternative would remain.
- Historic Resource Impacts. These alternatives would pass through a property that is potentially eligible for the National Register of Historic Places. (Property has since lost eligibility because of modifications made by owner).

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- Citizens' Advisory Committee and Agencies Responses

Several agency and Citizens' Advisory Committee representatives responded that the community and natural resource impacts to the Blackberry Valley and Bailey Camp areas would be too great with these alternatives to warrant further consideration. However, a few Citizens' Advisory Committee members indicated a preference for this southern terminus. They thought this is as close as a bypass could come to the Town of Blowing Rock without having adverse community and environmental impacts. They also indicated that bypass users would avoid several of the sharp curves on US 321 south of the Town Limits.

South End Alternatives "D", "E", and "F". These south end alternatives would begin just south of the Blowing Rock Town Limits.

- Advantages

- Cost. Alternatives that begin at this point would have the lowest construction costs.
- Traffic. These alternatives would leave very little (0.0 to 0.25 mile) of existing US 321 south of Blowing Rock unimproved. This means that users of the existing highway would not have to negotiate the narrow lanes and many of the sharp curves currently found on the existing route. However, they would have to pass through the curves on existing US 321 between Bailey Camp and Blowing Rock, an area where sharp curves (20 to 45 mph design speeds) and steep grades (6.6 to 7.6 percent) would remain with the Widening Alternative.
- Natural Resource Impacts. These alternatives would avoid the undisturbed wildlife habitat south of Blowing Rock.
- Community Impacts. These alternatives would have the least impact on communities south of Blowing Rock.

- Disadvantages

- Traffic. A bypass using the "D" south end alternative would be longer than the existing road, making it less attractive to local traffic. This is not the case with Alternatives E and F or any other of the alternatives that end south of the Blue Ridge Parkway.

Traffic on US 321 would pass through 2.5 to 3.5 miles more of road construction than with "A", "CC-A", "B", and "CC-B" alternatives and 1.3 to 1.5 miles more than with the "C" and "CC-C" alternatives.

Furthermore, these alternatives, offer fewer opportunities for travelers to avoid the six to eight percent grades on the existing road: 1.9 to 2.1 miles more of the six to eight percent grades with the "D" alternative than the "A" and "CC-A" and 1.3 to 1.5 miles more than with "C" and "CC-C". Traffic would pass through five ("D" alternatives) to seven (alternatives E and F) curves with less than a 50 mph design speed.

- Community Impacts. The southern portion of these alternatives is primarily widening existing US 321. Twelve homes would be relocated and the noise impacts associated with traffic on existing US 321 would remain.

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- Historic Resource Impacts. Alternatives E and F would be designed to avoid impacts to historic resources. Alternative D would affect a property potentially eligible for the National Register of Historic Places.

- Citizens' Advisory Committee and Agencies Responses

A majority of the agencies indicated a preference for a bypass alternative with a southern terminus because of its lower cost and minimization of natural resource and community impacts in the rural areas south of Blowing Rock. Citizens' Advisory Committee members were less enthusiastic. The majority believed that these alternatives were too close to Blowing Rock and would have detrimental effects on the Town.

North End Alternative E. Alternative E would begin just east of Green Hill and end at the Possum Hollow Road/US 321 intersection.

- Advantages

- Cost. This alternative is the lowest cost bypass alternative for the following reasons: 1) it would require the least amount of earthwork, 2) it would have the narrowest footprint, and 3) it would be the shortest alternative.
- Traffic. Alternative E would divert the most amount of traffic from existing US 321.
- Visual Impacts. According to representatives of the National Park Service, this alternative would have the least visual impact on the Blue Ridge Parkway.
- Community Impacts. This alternative would have the least effect on the Blowing Rock Assembly Grounds.
- Historic Resource Impacts. Alternative E could avoid use of National Register eligible properties.

- Disadvantages

- Natural Resource Impacts. This alternative would cross one wetland, resulting in a loss of 0.7 acre.
- Community Impacts. Alternative E would relocate 20 homes. Most of this displacement would occur in the Green Hill Road, Wonderland Drive, and Possum Hollow Road communities. This alternative would be closest to the most heavily developed areas of Blowing Rock; however, displacement of homes on top of Green Hill generally would be avoided.

- Citizens' Advisory Committee and Agency Response

One member of the Citizens' Advisory Committee supported this alternative. Most of the other members believed the community impacts in Blowing Rock would be too severe, particularly in the Green Hill neighborhood and along Green Hill and Possum Hollow Roads. Agency representatives who supported this alternative cited cost, minimal impacts to natural resources, and minimal visual impacts on the Blue Ridge Parkway as their reasons.

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North End Alternative F. Alternative F would begin east of Green Hill and pass north of the Blowing Rock Assembly Grounds Lodge before ending at US 321 in the Possum Hollow Road area.

- Advantages
  - Cost. This alternative would have the second lowest total construction cost.
  - Traffic. This alternative would attract substantial traffic from existing US 321.
  - Visual Impacts. Alternative F would be second best (compared to Alternative E) in minimizing visual impact to the Blue Ridge Parkway.
- Disadvantages
  - Natural Resource Impacts. This alternative would result in the loss of 1.1 acres of wetlands.
  - Community Impacts. This alternative is one of several that would have the greatest impact on the Blowing Rock Assembly Grounds. It would replace current forest views from the lodge with views of the bypass. In addition, natural areas used by retreat participants and a marked trail would be displaced, and the entrance to the Assembly Grounds would be altered.

Additionally, the potential for displacement is greatest with this north end alternative. Although homes on top of Green Hill would be avoided, 23 homes (in 1997) would be displaced in the Green Hill Road, Wonderland Drive, Goforth Road, and Possum Hollow Road communities.

- Historic Resource Impacts. Alternative F would not affect any National Register eligible properties.
- Citizens' Advisory Committee and Agency Response

As with Alternative E, there was little support among Citizens' Advisory Committee members and widespread support among agency representatives for this alternative. The reasons cited were generally the same as with Alternative E for both groups. Agency representatives believe it would be less costly and minimize natural resource impacts; Citizens' Advisory Committee members believe it would involve substantial community impacts to the Green Hill and Possum Hollow Road areas.

Original North End Alternatives A, B, C, and D. This north end alternative would pass between the Assembly Grounds' lodge and the Blue Ridge Parkway and end at Possum Hollow Road.

- Advantages
  - Traffic. As with many other north end alternatives, this one would attract substantial traffic from existing US 321.
  - Visual Impacts. North of the Green Hill Road area, views from the Blue Ridge Parkway would be blocked by the terrain.



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- Disadvantages

- Cost. The cost of this north end alternative could be the lowest of the corridors that top the Blue Ridge escarpment near the Blue Ridge Parkway, but only if an eight percent grade were maintained from the Blowing Rock Assembly Grounds to almost the US 321/Possum Hollow Road intersection. If a shallow grade were introduced approximately 1,100 feet from US 321, the earthwork would increase and costs would increase by about \$10 million (1996 dollars).
- Visual Impacts. This alternative would replace current forest views from the Assembly Grounds lodge with views of the bypass. In addition, it would be within views from the Thunderhill overlook and within views of the Green Hill Road area from the Blue Ridge Parkway.
- Community Impacts. Along with Alternative F, this north end alternative would have the greatest impact on the Assembly Grounds. Natural areas used by retreat participants and a marked trail would be displaced, and the entrance to the Assembly Grounds would be altered.

Furthermore, up to 20 homes (as of 1997) could be displaced in the Green Hill Road (Craig farm area), Goforth Road, and Possum Hollow Road communities. This number could be reduced substantially (as of 1997) in the Heather Ridge Lane area, but earthwork costs would increase.

- Citizens' Advisory Committee and Agency Response

Neither the Citizens' Advisory Committee nor the agency representatives expressed support for this north end alternative. Concerns included visual impacts to the Blue Ridge Parkway, impacts to the residential communities in the Green Hill and Possum Hollow Road areas, and impacts to the Blowing Rock Assembly Grounds. Many Citizens' Advisory Committee members expressed concerns about congestion and safety at the intersection of US 321/Possum Hollow Road/Shoppes on the Parkway. This concern also would apply to Alternatives E and F and any "G" alternative.

North End Alternative G. This alternative, which was used to form Alternatives AG, BG, CG, and DG, would pass through the southeast part of the Blowing Rock Assembly Grounds and continue to Possum Hollow Road.

- Advantages

- Cost. Costs for the "G" alternative are only slightly higher than for the original A, B, C, and D alternatives described in the previous section. "G" would include flatter grades (6.5 percent maximum) also.
- Traffic. As with the previous north end alternatives, this alternative would attract substantial traffic from existing US 321.
- Visual Impacts. North of the Green Hill Road area, views from the Blue Ridge Parkway would be blocked by the terrain.

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- Community Impacts. The “G” alternative would have less impact on the Blowing Rock Assembly Grounds’ operations than north end Alternatives.
  - Disadvantages
    - Visual Impacts. This north end alternative would be within views from Thunderhill overlook and within views of the Green Hill Road area from the Blue Ridge Parkway.
    - Community Impacts. Nineteen (19) homes (as of 1997) could be displaced within the Green Hill Road area, Goforth Road, and Possum Hollow Road communities. As with the previous north end alternative, displacement could be reduced substantially (as of 1997) in the Heather Ridge Lane area, but earthwork costs would increase.
  - Citizens’ Advisory Committee and Agency Response

Citizens’ Advisory Committee members indicated that, although this north end alternative would have less impacts on the Blowing Rock Assembly Grounds than the original A, B, C, and D north end alternatives, it still would have substantial community impacts and, therefore, was unacceptable. There was more support from agency representatives to this alternative primarily because it would have less of a visual impact on the Blue Ridge Parkway.

North End Alternative H. The “H” alternative would parallel closely the Blue Ridge Parkway and end at US 321 between the Parkway and Moses Cone Park.

- Advantages
  - Traffic. As with the others, this alternative would attract substantial traffic from existing US 321.
  - Visual Impacts. North of the Green Hill area, views from the Blue Ridge Parkway would be blocked by the terrain. It would not be within views from the Blowing Rock Assembly Grounds’ lodge.
  - Community Impacts. This north end alternative would avoid most of the communities south of the Parkway; however, it would pass through a developing area on Green Hill Road and undeveloped portions of the Hillwinds Estates off Possum Hollow Road. It would displace two homes and a restaurant/motel.
- Disadvantages
  - Cost. Of all the north end alternatives, the “H” alternatives would pass through higher terrain with the most regularity, increasing the amount of earthwork and construction costs. Steeper grades would reduce the amount of earthwork and the cost of this alternative.
  - Visual Impacts. This alternative would be within view from Thunderhill overlook and the Green Hill Road area from the Blue Ridge Parkway. Parkway officials consider this north end alternative to have the greatest potential for visual impact because, if the existing forest were to die, the bypass would be visible clearly from the Parkway for its full length parallel to the Parkway.

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- Community Impacts. This alternative would pass through a developing area on Green Hill Road and undeveloped portions of Hillwinds Estates. It would displace a restaurant/motel on US 321. Also, at the Blowing Rock Assembly Grounds, it would displace natural areas used by retreat participants and a marked trail.

- Citizens' Advisory Committee and Agency Response

One member of the Citizens' Advisory Committee and no agency representatives indicated that this north end alternative should be carried forward to the DEIS. Among the reasons cited for eliminating this alternative from further consideration were high costs and visual impact on the Blue Ridge Parkway.

North End Alternatives I and J. These north end alternatives would cross the Parkway in a tunnel and continue north to US 321 at Aho Road.

- Advantages

- Community Impacts. The "I" and "J" alternatives would pass through only one community, the Thunder Mountain Road community. They would avoid completely the communities within Blowing Rock. They also would avoid the Blowing Rock Assembly Grounds.

- Disadvantages

- Cost. These would be the most expensive north end alternatives because of the tunnel under the Blue Ridge Parkway.
- Traffic. These north end alternatives would attract the least amount of traffic from US 321 to the bypass.
- Visual Impacts. The alternative would be visible from the Thunderhill overlook and according to Parkway officials, would have a substantial visual impact on the Parkway.
- Community/Natural Resource Impacts. Both of these alternatives would pass through the Thunder Mountain Road community. The "I" alternative would displace 21 homes (including a mobile home park with 19 mobile homes) and would avoid wetlands. The "J" alternative would avoid the 21 homes but would fill wetlands (3.44 acres).

- Citizens' Advisory Committee and Agency Response

The majority of the Citizens' Advisory Committee members supported one of these north end alternatives. The Town Council of Blowing Rock also indicated unanimous support for an alternative that crossed the Parkway in a tunnel. Some citizen advisory committee members believe the only "true bypass" is one that avoids Blowing Rock's residential communities completely. Agency representatives and the Citizens' Advisory Committee members who opposed these north end alternatives cited costs and impacts to the Blue Ridge Parkway as primary concerns.

***Alternatives Eliminated from Detailed Evaluation in the DEIS***

South End Alternatives. The study team eliminated the "A", "CC-A," "B", and "CC-B" alternatives from further consideration because they would involve higher costs, more earthwork,

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greater natural resource impacts, social impacts to the rural communities south of Blowing Rock, and would leave a substantial length of US 321 unimproved. The study team concluded that the advantages of these alternatives were not great enough to outweigh the disadvantages. The section of widening between the start of these alternatives and the start of the “C” and “CC-C” alternatives would meet the project’s design criteria for horizontal curves. In this same section, the widening project would have only three locations where the grades were greater than six percent. The “D” alternative was eliminated from further consideration because it did not address one of the primary concerns of several members of the Citizens’ Advisory Committee: it would not bypass an approximately two-mile section of steep grades and sharp curves on existing US 321 (neither does E or F) as it approaches Blowing Rock.

The “C” and the “CC-C” alternatives are design variations within the same corridor. The “C” design was eliminated in favor of the “CC-C” design because the “CC-C” design would connect to two of the selected north end alternatives and includes two features favored by several members of the Citizens’ Advisory Committee: flatter grades and fewer relocation impacts.

North End Alternatives. All the alternatives that end at Possum Hollow Road except Alternative E were eliminated from further consideration because this northern ending point was opposed by most members of the Citizens’ Advisory Committee, citizens attending the August 1, 1995 Citizens Informational Workshop, and the Blowing Rock Town Council. The potential impacts of these alternatives to the Blowing Rock Assembly Grounds also were a factor.

The “J” tunnel and design north of the Blue Ridge Parkway also were dropped from further consideration. The differences between the “J” route and the selected “I” route are small.

#### ***Alternatives Selected in 1997 for Detailed Evaluation in the DEIS***

At the end of the 1997 study, four alternatives were selected for detailed evaluation in the DEIS. These alternatives are shown in Figure 2-8. Alternative E; FH, a combination of Alternative F with the northern ending point used for Alternatives CC-AH, CC-BH, and CC-CH; CC-CH; and CC-CI (includes a tunnel) were selected for the following reasons:

- Alternative E (Bypass Alternative 1)
  - It is the shortest and least expensive bypass alternative.
  - It can be designed to avoid area historic resources.
  - It would have the least visual impact on the Blue Ridge Parkway.
  - It would have a minimal impact on the Blowing Rock Assembly Grounds when compared to the other alternatives ending south of the Blue Ridge Parkway.
- Alternative FH (Bypass Alternative 2)
  - It can be designed to avoid area historic resources.
  - Its northern terminus is between the Blue Ridge Parkway and Possum Hollow Road. The Blowing Rock Town Council and many members of the Citizens’ Advisory Committee objected to a northern terminus at Possum Hollow Road.

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**Figure 2-8. Bypass Alternatives 1 to 4**

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- Alternative CC-CH (Bypass Alternative 3)
    - Representatives from the Concerned Citizens of Blowing Rock supported a US 321 bypass that remained south of the Parkway and as close to the Parkway as possible.
    - It bypasses the final curves on existing US 321 before Blowing Rock. This section of existing US 321 would remain unimproved with the Widening Alternative. This feature is also important to many citizens.
  - Alternative CC-CI (Bypass Alternative 4)
    - It avoids the Town of Blowing Rock by ending north of the Parkway, a feature important to the Town Council of Blowing Rock and too many members of the Citizens' Advisory Committee.
    - It bypasses the final curves on existing US 321 before Blowing Rock, like CC-CH.

These alternatives were selected for comparison to the Widening Alternative. Each offered different advantages and disadvantages for particularly costs, social impacts, and natural resource impacts. The support each has from agencies, the Citizens' Advisory Committee, and citizens in general differs.

### **2.2.3 1999 Widening Proposal**

The NCDOT, concerned about the large amount of earthwork, the cost, natural resource impacts, and visual impacts associated with the Bypass Alternatives, held a meeting in March 1999 with the Town Council of Blowing Rock, Caldwell County and Watauga County Commissioners, and the Citizens Advisory Committee. Members of the public also attended. The Secretary of Transportation presented a video that proposed that Bypass Alternatives 2, 3, and 4 be dropped from further consideration. Bypass Alternative 1 would be retained for analysis because it avoided historic properties impacts.

The Secretary observed that Bypass Alternatives 3 and 4 would require the greatest amounts of earthwork. Based on conceptual designs prepared in 1998 that considered geotechnical studies conducted by the NCDOT in 1998, Bypass Alternative 4 would require the movement of nearly 10 million cubic yards of earth and rock. This amount of material would fill over 150 football fields to the top of the goal posts. Bypass Alternative 3 would require over 12 million cubic yards of earth and rock movement. The Widening Alternative (based on the 1994 design) would require, by contrast, the removal of about 800,000 cubic yards, almost all of which would be outside of Blowing Rock. Large amounts of earthwork or retaining walls result in high costs, with Bypass Alternative 4, the tunnel alternative, being the most costly at \$108 million dollars. The cost of the other bypass alternatives would range from \$44.4 to \$77.1 million. The Widening Alternative would cost about \$23.5 million. These are all 1998 construction cost estimates using the 1994 widening design and 1998 conceptual bypass designs.

The NCDOT also acknowledged that while the concerns of cost, earthwork, natural resource loss, rural community disturbance, and visual impact that are associated with the bypass alternatives are important, they are no less important than the concerns of possible adverse effects to the unique and historic character of Blowing Rock.

The NCDOT recognized that the concerns associated with the Widening Alternative must be directly and creatively addressed. The NCDOT proposed, as a part of the Widening Alternative, to pay for landscaping and other amenities along the widened road. One approach was illustrated

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using four photorealistic simulations of the widened road. Utilities would be moved underground. A landscaped median was proposed in front of the Green Park Inn. Existing small rock walls displaced by the widening would be replaced and extended. Period lampposts could be added at the Green Park Inn to enhance the historic feel of the area and the pedestrian crossing could be accentuated with contrasting paving materials. Along the commercial section of US 321, the NCDOT suggested a landscape design plan to bring this area closer in line with the character of the rest of the community.

The NCDOT committed to the citizens of Blowing Rock that it would work with the community to create a construction phasing and traffic management plan that would minimize construction impacts. These commitments are reflected in the landscape plans in Appendix D and the construction discussion in Section 4.16 of Chapter 4, the Memorandum of Agreement signed in 2004 and presented in Appendix G, and the Memorandum of Understanding signed in 1994 and presented in Appendix G.

The NCDOT asked meeting attendees to provide comments on its proposal. Those comments included support for both the Widening Alternative and Bypass Alternative 4.

#### **2.2.4 Selection of the Alternatives to be Evaluated in the EIS**

In July 1999, the NCDOT amended its 1997 decision and decided that the Widening Alternative, Bypass Alternative 1, and Bypass Alternative 4 would be evaluated in detail in the EIS. This decision was discussed with state and federal environmental resource and regulatory agencies. The FHWA also participated in these discussions. The evaluation of these alternatives is presented in Chapter 4 of the FEIS. They are described in this chapter in Section 2.4.

##### ***July 1999 Decision***

In a July 20, 1999 letter to area public officials and the Citizens Advisory Committee, the NCDOT announced its decision to evaluate in detail three alternatives in the EIS: the Widening Alternative, Bypass Alternative 1, and Bypass Alternative 4. Bypass Alternatives 2 and 3 were eliminated from further consideration.

In the letter, the NCDOT noted that although Bypass Alternative 4 would have high cost and substantial natural resource and visual impacts, it would be evaluated in detail because it has strong public support. Bypass Alternative 1 would be evaluated in detail because it avoids all impacts to historic properties.

##### ***Agency Approval of Alternatives***

The NCDOT, the FHWA (for federally-funded projects), and the US Army Corps of Engineers (USACE) entered into an agreement in 1997 to integrate the regulatory requirements of the National Environmental Policy Act and Section 404 of the Clean Water Act. This agreement ensures that state and federal environmental regulatory resource agencies that have an interest in the issuance of USACE dredge and fill permits for wetland and stream impacts under the terms of Section 404 are afforded the opportunity to participate in the transportation decision-making process. The agreement stipulates concurrence among participants or “merger-team members”, at various decision making points in the integration or “merger process”, including step 1: purpose and need, step 2: alternatives for detailed study, step 2a: bridge locations and lengths, step 3: identification of Least Environmentally Damaging Practicable Alternative (LEDPA), and steps 4a, 4b, and 4c: impact avoidance and minimization at various points in the design. The merger process was implemented for the US 321 project at step 2- alternatives for detailed study. The

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NCDOT requested concurrence from the merger team for the three alternatives selected in July 1999. The majority of the merger team members indicated that they did not agree Bypass Alternative 4 should be studied in detailed in the EIS. The NCDOT emphasized that this corridor was preferred by many citizens and that it was critical it be evaluated in full in the EIS. Most agency representative declined to sign a concurrence form that included Bypass Alternative 4. Consequently, the language for the signed concurrence agreement indicates concurrence on the Widening Alternative and Bypass Alternative 1 only. The merger team understood that the NCDOT would evaluate Bypass Alternative 4 in full in the EIS.

## **2.3 Alternatives to a Four-Lane Project**

This section discusses the characteristics of alternatives to the four-lane Build Alternatives and their ability to meet the capacity and safety needs for the proposed project. These alternatives are: the No-Build Alternative; Postponement of Improvements; Redesignation of US 321; Transit; and Transportation Systems Management improvements (improved two-lane and three-lane alternatives). None of these alternatives would meet the purpose and need of the US 321 improvements project. The alternatives are listed as follows:

- No-Build;
- Postponement of Improvements;
- Redesignation of US 321;
- Improving the Connection Between Hickory, NC and US 421;
- Transit;
- Transportation System Management (TSM); and
- Partial Four-Lane Project.

### **2.3.1 No-Build**

The No-Build Alternative consists of the existing transportation system plus the other programmed transportation improvements listed for Blowing Rock and northwestern North Carolina in the NCDOT 2006-2012 *Transportation Improvement Program*. These projects are listed in Section 1.4.3 of Chapter 1. The No-Build Alternative would not increase the capacity of US 321 in the project area or change road features that contribute to the area's high crash rates. However, the No-Build Alternative is always an alternative that could be selected as the Preferred Alternative; therefore, it is compared with the Build Alternatives in Chapters 4 and 5 of the EIS.

### **2.3.2 Postponement of Improvements**

With this alternative, no immediate capital investment in US 321 improvements would be made. Consequently, postponement would result, in steadily worsening traffic flow and crash conditions. Right of way costs would almost certainly rise because of increased property values. Construction cost also would increase. Project impacts would ultimately occur and could be worse in the future because of additional development. Thus, delaying implementation of the improvement project is not proposed.

### **2.3.3 Redesignation of US 321 between Lenoir, NC and Hampton, TN**

During the preparation of the 1993 Environmental Assessment, the Concerned Citizens of Blowing Rock citizens group proposed that a different highway route between Lenoir, North



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Carolina and Hampton, Tennessee be designated as US 321. The redesignation would be made as an alternative to widening US 321 from Patterson to Blowing Rock.

The location of the citizen-proposed route and existing US 321 is illustrated in Figure 2-9. The citizen-proposed route follows the following roads from Lenoir to Hampton:

- Southwest Lenoir Bypass from US 321 to NC 18;
- A proposed new road from NC 18 to SR 1310;
- SR 1310 to NC 90;
- NC 90 to SR 1337;
- SR 1337/SR 1335/SR 1405 to NC 181;
- NC 181 (including the segment between Pineola and the Linville Bypass that is also designated as US 221) to NC 194 at Linville, North Carolina (including the Linville Bypass);
- NC 194 via Newland, North Carolina to US 19E near Elk Park, North Carolina; and
- US 19E to US 321 at Hampton.

The citizen-proposed route is 69 miles long. Existing US 321 from Lenoir to Hampton is 66 miles long.

A study of the merits of this alternative was conducted in 1992. The study was:

- Designed as a general look at the proposed route's opportunities and difficulties. It was assumed that additional, more detailed studies would be conducted if the findings of the general study were inconclusive or indicated that the citizen-proposed route was a reasonable alternative to widening US 321.
- Designed to focus on the various merits of the proposed route that were identified by citizens that proposed the alternative.

The study found no particular roadway design or environmental issues that would make the redesignation of the citizen-proposed route as US 321 difficult. However, the citizen-proposed route would not serve as an alternative to widening US 321 from Patterson to Blowing Rock because:

- The amount of traffic that would shift to the redesignated route would be small, and
- The capacity and safety needs of US 321 between Patterson and Blowing Rock would not be changed.

Study methods and findings are described in *Evaluation of an Alternative Route for US 321 between Lenoir, North Carolina and Hampton, Tennessee* (Parsons Brinckerhoff Quade & Douglas, Inc., June 25, 1992). The paragraphs that follow present the key discussions of findings contained in that study with relevant updates. The study area was re-visited in the fall of 2000 and no reason was found to alter the conclusions of the 1992 study.

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**Figure 2-9. US 321 Redesignation Alternative**

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### ***Roadway Design Findings***

The study did confirm the citizens' observation that their proposed route was of generally good quality. No particular roadway design issues were identified that would impede the redesignation of the citizen-proposed route as US 321. At a minimum, however, 13.6 miles of the route (from SR 1310 to NC 181) would need to be upgraded to current two-lane rural highway design standards. This section has narrow lanes, inadequate shoulders, and substandard sight distances. Sharp bends at the intersections of SR 1310/NC 90 and SR 1405/NC 181 also should be corrected. These conclusions were based on the existing characteristics and planned improvements described in the subsections below. Finally, as discussed below under "Traffic Findings," the redesignation should not significantly change traffic volumes on the citizen-proposed route, thus other design changes do not appear warranted based solely on a redesignation.

Existing Characteristics. The proposed route is primarily a two-lane facility. Four-lane sections occur at each end and have a total distance of 9.5 miles. Passing lanes occur along the northern half of the proposed route. They are almost continuous in Tennessee. Standard 12-foot lanes are found on all but the 13.6 miles of the route that follow Secondary Roads (SR). An adequate shoulder, although not always to current standards, is provided along 60 percent of the route's length. With the exception of posted curves (primarily along a 15.2-mile section of NC 181), the horizontal alignment can be driven by a passenger car at the posted speed. This may not hold true for semi-trucks since road operating characteristics vary. The vertical alignment along approximately 18.7 miles of the route limits sight distances at crests of vertical curves. Most of this concern is along the 13.6 miles of SR portions used at the southern end of the route. Steep grades occur in two sections (totaling 13.4 miles) of the route.

Conversations with the NCDOT's Division 11 (Caldwell and Avery Counties) and Division 13 (Burke County) engineers, as well as the Burke County Maintenance Engineer (at the suggestion of the Division 13 engineer) yielded the following information:

- In their experience the weather-related problems at upper elevations of the citizen-proposed route and existing US 321 are not substantially different;
- The only new improvement planned as of 1992 by the Divisions for the citizen-proposed route is repaving in the Cold Springs area (near Upper Creek in Burke County);
- Truck escape ramps should be considered for the long, steep grade on NC 181 in Burke County; and
- Slope stability and maintenance (except in the area to be repaved) are not a problem along the proposed route.

Planned Improvements. The North Carolina Transportation Improvement Plan for 1993 to 1999 (August 1992) listed two improvements along the citizen-proposed route. The first was a new road from NC 18 to SR 1310 (R-2626) that is listed above as a part of the citizen-proposed route. The second is widening US 221/NC 181 to four lanes between Pineola and the Linville Bypass. The Tennessee Department of Transportation had no plans at that time to improve either existing US 321 or US 19E (citizen-proposed route) from the North Carolina line to Hampton.

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### ***Traffic Findings***

If it were designated as US 321, the amount of traffic that would shift to the citizen-proposed route, including trucks, would be small. The future capacity needs of US 321 between Patterson and Blowing Rock would not be changed. Currently, far fewer vehicles use US 321 for trips between North Carolina and Tennessee than use US 19E. Planned Interstate highway improvements in the western North Carolina/eastern Tennessee region (now completed) were expected to further reduce the limited desirability of US 321 as a through route from Tennessee to Lenoir.

Annual Average Daily Traffic. Existing traffic volumes on the citizen-proposed route were generally low. Volumes are the greatest at the northern end of the route. Annual average daily traffic (AADT) on SR 1310/NC 90 was 1,500 to 1,800 vehicles in 1991. The AADT was only 700 vehicles on the SR 1337/SR 1335/SR 1405 section of the route and was 1,800 to 2,100 vehicles on NC 181. Average daily volumes on NC 194 and US 19E to the state line were 5,000 to 5,300 vehicles in 1991. In Tennessee, the 1991 AADT rose from 5,640 vehicles at the state line to 8,170 at Hampton.

On existing US 321, the 1991 AADT was greatest in the Lenoir (9,200 to 10,000 vehicles between Lenoir's north city limits and NC 268) and Boone (11,400 to 14,900 vehicles) areas. There were 5,800 to 6,200 vehicles between NC 268 and Blowing Rock, 6,800 vehicles in Blowing Rock, and volumes declined west of Boone to only 1,110 at the state line. Thus, far fewer persons used US 321 for trips between North Carolina and Tennessee (1,110 AADT) than use US 19E (5,300 to 5,640 AADT). In Tennessee, volumes on US 321 rose from the 1,110 vehicles at the state line to 5,400 vehicles at Hampton. Much of the rise is probably attributable to Tennessee residents traveling to the Watauga Lake recreation area.

The NCDOT's 2003 Annual Average Daily Traffic maps show a pattern similar to the 1991 maps. Again, AADT declines on US 321 as one moves west of Boone, from 15,000 vehicles per day west of SR 1107 to 460 vehicles per day at the Tennessee State Line. In 2003 like 1991, far fewer persons used US 321 for trips between North Carolina and Tennessee (460 AADT) than use US 19E (5,900 AADT).

Potential for Through Trip Diversion. The potential for diverting through trips moving between Hampton, Tennessee and Lenoir, North Carolina from existing US 321 to the citizen-proposed route is small because the number of through trips between Hampton and Lenoir was small in both 1991 and in 2003, and is expected to continue to be small.

The 460 vehicles per day that reached the State Line on US 321 in 2003 represents less than five percent of the 1998 average annual daily traffic of 15,000 vehicles per day on US 321 just south of Sunset Drive in Blowing Rock. In addition, it can be assumed that only a fraction of the 460 vehicles reaching the State Line represent travelers driving from Lenoir to Hampton, Tennessee given the distance between the two cities and the large number of potential origins and destinations in between, including the Town of Boone. For example, the 1992 assessment of this alternative found that in 1989 approximately 47 vehicles per day operated on US 321 between the Watauga/Caldwell County line south of Blowing Rock and the Tennessee line, passing through Blowing Rock to and from Tennessee. This number was expected to rise to approximately 70 vehicles per day by 2020. This finding says that 100 percent diversion to the citizen-proposed route would only divert 70 trips through Blowing Rock per day in 2020.

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Thus, designation of the citizen-proposed route as US 321 would have no impact on the capacity needs of US 321 in Blowing Rock. In addition, the small shift in traffic would not affect the capacity needs of the citizen-proposed route.

Planned Interstate Highway Improvements in the Region. The 1992 study said that planned Interstate highway improvements in the western North Carolina/eastern Tennessee region were expected to reduce further the limited desirability of US 321 as a through route from Tennessee to Lenoir. Tennessee was in the process of improving US 23 between Erwin, Tennessee and the North Carolina state line to Interstate highway standards. Tennessee had already completed improving US 23 to interstate standards from I-81 to Erwin (via Johnson City and currently designated as I-181). North Carolina had programmed (project A-10) the construction of a four-lane freeway from Asheville to connect to the Tennessee project at the state line. The completed freeway was designated I-26. These projects are now complete and perhaps explain why the AADT on US 321 at the Tennessee State Line declined between 1991 and 2003.

Potential for Through Truck Trip Diversion. The potential for diverting through truck trips in Blowing Rock by designating the citizen-proposed route as US 321 is small because the number of through commercial trips between Hampton and Lenoir is small. For example, a 1989 Boone origin-destination study found that 31.5 percent of the through trips in Boone that moved between the US 421/321 intersection west of Boone and US 221 at Blowing Rock were commercial vehicles. Based on this percentage, it is estimated that approximately 15 commercial vehicles per day operated on US 321 between the Watauga/Caldwell County line south of Blowing Rock and the Tennessee line, passing through Blowing Rock to and from Tennessee. The 1992 study concluded that this number was expected to rise to approximately 22 vehicles per day by 2020. This finding says that 100 percent diversion to the citizen-proposed route would only divert 22 commercial trips through Blowing Rock per day in 2020.

Crashes. The Division 11 and Division 13 traffic engineers indicated that they knew of no particular crash problems on the citizen-proposed route.

### ***Environmental Impact Findings***

No particular environmental impact issues were identified that would impede the redesignation of the citizen-proposed route as US 321. If improvements were made to the route, impacts to the human and natural environments would occur, as they do for most highway improvement projects. The human and natural environments along the citizen-proposed route can be characterized as follows:

- Rural with concentrations of homes and sometimes businesses in small communities along the road. Concentrations of rural development can be found along approximately 15 percent (8 of 52 miles) of the citizen-proposed route in North Carolina and most of the 17 miles in Tennessee. Less than 2 percent of the 13.6 miles of the citizen-proposed route that would need to be improved to meet current two-lane rural road standards has concentrations of rural development. Urban residential and industrial development occurs along the five-mile, four-lane Southwest Lenoir Bypass.
- Christmas trees and nursery stock are grown along much of combined SR 1337/SR 1335/SR 1405.
- Streams parallel the road for approximately 31 percent (16 of 52 miles) of the citizen-proposed route in North Carolina and most of the 17 miles in Tennessee. Seven percent of the 13.6 miles of the citizen proposed route that must be improved parallel streams. Only one

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large wetland area was identified during the 1992 study's field reconnaissance, although there are undoubtedly smaller wetlands that were not readily apparent.

- The following streams along the citizen-proposed route are classified as trout waters by the State of North Carolina:

<i>Trout Stream Name</i>	<i>Relation to Citizen-Proposed Route</i>
– Wilson Creek	crossed
– Carroll Creek	crossed and paralleled
– Upper Creek	crossed
– Camp Creek	paralleled
– Linville River	crossed and paralleled
– Stacey Creek	crossed and paralleled
– Kentucky Creek	crossed and paralleled
– North Toe River	crossed
– Blood Camp Branch	crossed
– Whiteoak Creek	paralleled
– Blevins Creek	paralleled
– Cranberry Creek	crossed
– Little Elk Creek	crossed

Wilson Creek, which would be crossed, is also classified as an Outstanding Resource Water. Upper Creek (crossed) and Steels Creek (both crossed and paralleled) are classified as High Quality Waters. Steels Creek is not a trout water.

Wilson, Carroll, and Upper Creek are found along the segment of the citizen-proposed route that would need to be improved. These three streams plus Camp Creek, Steels Creek, and the Linville River are found along the citizen-proposed route between Lenoir and US 221 south of Linville.

- Representatives of the Pisgah National Forest, Cherokee National Forest and the North Carolina Division of Environmental Management indicated that if the NCDOT decided to improve the citizen-proposed route, the NCDOT would have to handle the usual array of natural resource issues and follow the usual procedures for identifying impacts and mitigation measures. They identified no highly unique resources for which impacts would be extraordinarily difficult to mitigate. NC 181 passes through the midst of the Pisgah National Forest for 17.6 miles. The Cherokee National Forest flanks US 19E from the state line to Hampton, Tennessee; however, almost all of the land adjoining US 19E is in private hands.

The potential for environmental impact would depend upon whether a redesignated US 321 is improved only along the 13.6 miles of SR roads or if more extensive modifications are deemed necessary. The principal environmental issues related to improving the 13.6 miles of SR roads appear to be farmland loss and protection of trout waters and an outstanding resource water. Some displacement of homes is also possible. If the decision was made to designate the citizen-proposed route between Lenoir and US 221 south of Linville as US 321 and a North Carolina intrastate corridor, approximately 33 miles of widening to four lanes would be required. The length of existing US 321 from Patterson to Blowing Rock is 15.1 miles. In addition to length, the magnitude of the impact of four lanes would depend on the width of the four-lane typical

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section used and the earthwork that would be involved, particularly where streams are paralleled. Principal environmental issues appear to be protection of trout, outstanding resource, and high quality waters; use of National Forest lands; avoiding stream modifications and floodplains; wildlife habitat loss; displacement (particularly at Jonas Ridge); and farmland loss along the 13.6 miles of SR roads.

### 2.3.4 Improving the Connection between Hickory, NC and US 421

Improving the connection between Hickory, North Carolina and US 421 as an alternate route to US 321 for travelers between Hickory and Boone was considered based on comments made at the Public Hearings. The distance from Hickory to Boone was found to be substantially greater when taking such an alternate route instead of US 321. For example, the distance from Hickory to Boone using US 321 is 48 miles; using US 321, NC 18 and US 421 the distance is 80 miles, so through travelers are unlikely to choose this alternate route. The two routes are illustrated in Figure 2-10.

### 2.3.5 Transit Alternative

The potential for transit to meet the project's purpose and need was examined from two perspectives. First, a trip end model was used to estimate a potential transit ridership rate. Second, an estimate was made of the percent of the design hour automobile traffic using US 321 that would have to change modes, that is, use transit instead of the automobile, to achieve the goal of level of service (LOS) C on US 321 in 2025. Table 1-2 in Chapter 1 defined the LOS designations. The model concluded that less than one percent of the trips in the Blowing Rock area were likely to use transit. The second analysis found that at one location, 55 percent of all design hour automobile traffic on US 321 in 2025 would have to change modes to achieve LOS C. At another location, 70 percent would need to change modes. The above studies indicate that transit could not meet the purpose and need of the project.

#### *Modeled Estimate of Potential Transit Ridership Rates*

Mode choice and transit usage can be estimated using trip end models. These models determine the percentage of total person trips that would use transit and are based on land use or socioeconomic characteristics of an area. The following trip end equation was used:

$$Urban Travel Factor = \left( \frac{1}{1000} \right) \times \left( \frac{Households}{Automobiles} \right) \times \left( \frac{Persons}{Square mile} \right) \quad (\text{Garber, 1997})$$

Using data from the 1990 US Census, this equation applied to Blowing Rock is:

$$Urban Travel Factor = \left( \frac{1}{1000} \right) \times \left( \frac{559}{1033} \right) \times \left( \frac{1323}{3} \right) = 0.81\%$$

Using the same relationships of persons per household and automobiles per household as the 1990 Census but with the current estimated 10,000-person summer population of Blowing Rock, the equation would be:

$$Urban Travel Factor = \left( \frac{1}{1000} \right) \times \left( \frac{4220}{7800} \right) \times \left( \frac{10,000}{3} \right) = 1.80\%$$

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**Figure 2-10. Alternate Route from Hickory to Boone**



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This method indicates less than two percent (0.81 to 1.80 percent) of automobile users in Blowing Rock could be expected to use transit, far less than the number needed to make transit a viable alternative to capacity improvements for US 321.

### ***US 321 Traffic That Would Need to Change Modes***

In addition to the basic modeled estimate, a sensitivity analysis also was conducted to determine how successful transit would need to achieve LOS C on US 321 in 2025. Realistically, only some types of automobile trips could also be served by transit. Three basic trip types were examined: through trips, trips with an origin or destination in Blowing Rock, and trips within Blowing Rock. Two analyses were conducted, one excluding through trips as likely transit users and the other assuming that transit users could be attracted from all trips.

The analysis assumed that the goal was to reduce design hour trips. The first analysis assumed that through trips were not viable sources for transit trips because weekend trips would include substantially fewer work trips than weekday trips and would include travelers with the greatest range of origins and destinations. The development of a park-and-ride system at the outskirts of Blowing Rock means that some trips (excluding trucks) to Blowing Rock or from Blowing Rock to other destinations could use transit. Residents and guests in Blowing Rock could use local buses that circulate on collector and arterial streets such as US 321, Sunset Drive, Main Street, Goforth Road, Green Hill Road, and Wonderland Drive.

As shown in Table 2-3, for two representative locations with different capacities and traffic volumes, even if all of these two types of trips used transit, the desired LOS C could not be fully achieved.

The second analysis of the model analyses was conducted that assumed all trips (except trucks) would consider using transit. The results of this assumption are shown in Table 2-4. Given the results of the model analysis, it is unlikely that transit would alleviate the need to improve the US 321 corridor since 55 to 70 percent of all automobile trips would need to change modes to achieve LOS C. According to *Highway Capacity Manual* (Transportation Research Board, 1998), 40 percent transit use is the maximum achieved in large cities with bus transit.

**Table 2-3. Percent of Local Automobile Trips and Automobile Trips with a Blowing Rock Origin or Destination that Must Use Transit to Achieve Various Levels of Service (Excludes Through Trips)**

LOS	US 321 at Goforth Road		US 321 at Sunset Drive	
	Existing	2025	Existing	2025
C – Desired	55%	NA <sup>1</sup>	15%	100%
D	0%	90%	0%	75%
E		15%		65%
F		0%		0%

<sup>1</sup> LOS C would require greater than 100 percent usage.

**Table 2-4. Percent of All Automobile Trips that Must Use Transit to Achieve Various Levels of Service**

LOS	US 321 at Goforth Road		US 321 at Sunset Drive	
	Existing	2025	Existing	2025
C – Desired	30%	70%	9%	55%
D	0%	50%	0%	45%
E	–	8%	–	35%
F	–	0%	–	0%

### 2.3.6 Transportation Systems Management (Two-Lane and Three-Lane Alternatives)

Transportation Systems Management (TSM) is defined as modest physical and operational improvements to traffic performance, safety, and management. These projects typically do not involve large capital outlays, and as a result, most (but not all) projects with substantial right-of-way acquisition are not considered TSM improvements. Potential TSM strategies that could be applied to the US 321 corridor include:

- Left- and right-turn lanes and/or a third turning lane;
- Widening the existing lanes to 12-foot lanes and standard shoulders;
- Straightening of sub-standard horizontal curves; and
- Elimination or substantial reduction of curb cuts (driveways).

Several references were consulted to perform the TSM analyses, including the *Highway Capacity Manual* (Transportation Research Board, 1998) and the Florida level of service tables (Florida Department of Transportation, 1995). Use of these sources is accepted by the NCDOT as a method of analyzing or determining level of service. Based on these references, eliminating driveways and improving curves would mainly improve safety and make only limited improvements in capacity. Thus, the focus of the TSM analyses is on the first two strategies, which historically provide the greatest improvements in traffic movement in a congested corridor. Given the community, cultural, and natural resource priorities in the project area, the TSM analysis also examined two conservative assumptions for the TSM alternative:

1. That LOS D would be acceptable in the design year; and
2. That community, cultural, and natural resource priorities would take precedent over the travel comfort of October and summer weekend travelers so long as LOS D was achieved during weekday peaks.

The assessment of these strategies was applied to the US 321 corridor for three sections:

1. Blackberry Road to Green Hill Road;
2. Green Hill Road to US 321 Business; and

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### 3. US 321 Business to US 221.

#### ***Data Used***

Daily peak period traffic volumes were collected at the two Automated Traffic Recording (ATR) stations on US 321 in the Blowing Rock area.

ATR Station 1302 is between Blackberry Road and Green Hill Road. Data from this station was collected for the period of October 1, 1998 to September 30, 1999. The days where data was not complete or was questionable because of counter errors were omitted from the analysis. This data showed that the highest hourly volumes over the year corresponded to weekend traffic during the fall colors, a peak tourist period. A typical weekday peak occurred at about the 190th highest peak hour over the course of a year.

ATR Station 9403 is on US 321 between US 321 Business and US 221. Data from this station was collected for the period from November 1, 1998 to October 31, 1999. The days where data was not complete or was questionable because of counter errors were omitted from the analysis. The highest hourly volumes corresponded to weekend traffic volumes during the peak fall tourist period. The typical weekday peak occurred at about the 375th highest hour over the course of a year.

No ATR station is between Green Hill Road and US 321 Business so an average of the two surrounding segments was used as the basis for the segment's peaking characteristics.

#### ***Road Capacity Changes with the TSM Options***

The addition of left- and right-turn lanes or a third turning lane could increase capacity on US 321 by five to 15 percent. Turn lanes also would improve the safety of the roadway by removing turning vehicles from the traffic stream. Capacity changes for the three sections would be:

- Blackberry Road to Green Hill Road (Rural Section): five percent increase in through capacity with turn lanes (reflecting that there are few turns made on this mostly undeveloped section of US 321);
- Green Hill Road to Business US 321 (Transitioning Section): 10 percent increase in through capacity with turn lanes; and
- US 321 Business to US 221 (Urban Section): 15 percent increase in through capacity with turn lanes, five percent with a median at locations with existing turn lanes.

The widening of through lanes and shoulders could potentially increase capacity on US 321 by three to 20 percent. Highway capacity studies indicate that traffic tends to flow better with standard lanes and shoulders because drivers feel safer. The standard width of a traffic lane is 12 feet and the standard width of a roadway shoulder is six feet for a road of US 321's functional classification and traffic volumes. Lane widths along existing US 321 vary from 10 to 11 feet, and shoulder widths are typically about two feet. Shoulder width is a factor on the rural section of US 321 only because urban sections do not have shoulders and there is no room to add them. The safety of the roadway would be improved by adding turn lanes and by widening existing travel lanes and shoulders. Capacity changes for the three analysis sections would be:

- Blackberry Road to Green Hill Road (Rural Segment): 19 percent increase in through capacity for widening to standard lane and shoulder widths;

- 
- Green Hill Road to US 321 Business (Transitioning Segment): three percent increase in through capacity for widening to standard lane widths; and
  - US 321 Business to US 221 (Urban Segment): three percent increase in through capacity for widening to standard lane widths.

### ***Capacity Analysis***

The existing and improved capacities for the three sections of the US 321 were plotted against the peak hourly volume curves (highest peak to lowest) for 1998 and 2025 (both based on the peaking pattern shown at the ATR stations) to determine where the various peak hours correspond to road capacity. These results are shown in Figure 2-11 to Figure 2-13. The design hour volume used in Chapter 1 for existing conditions and later in this Chapter for the Build Alternatives was 14 percent of the Average Daily Traffic.

Blackberry Road to Green Hill Road (Rural Section). Capacity on the rural section of US 321 could be increased up to 24 percent with wider lanes and shoulders and turn lanes. However, this section of US 321 would continue to operate at an undesirable design hour level of service with current traffic and in 2025, even during a typical weekday design hour. (See Figure 2-11.)

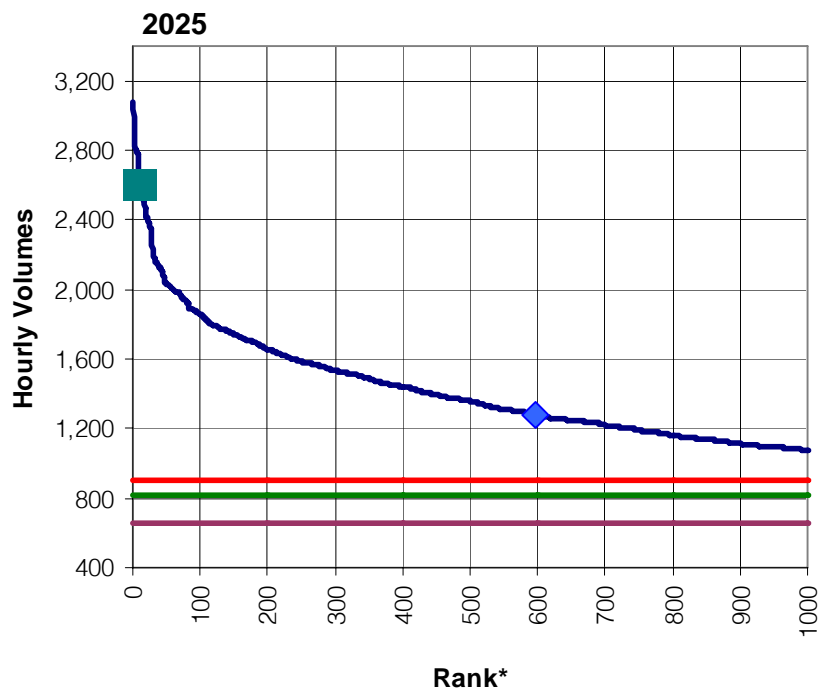
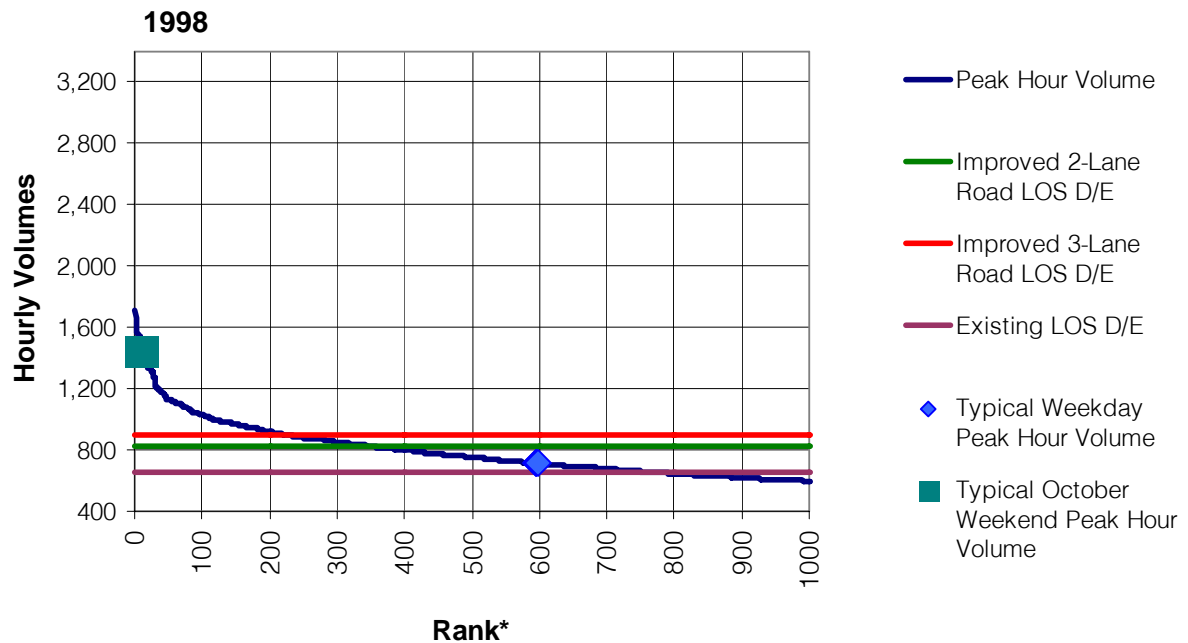
Green Hill Road to Business US 321 (Transitioning Section). Capacity on this section of US 321 could be increased up to 13 percent with wider lanes and shoulders and turn lanes. As shown in Figure 2-12, these improvements would result in LOS D in all design periods with current traffic volumes. By 2025, typical weekday design hour traffic would nearly LOS E. Weekend design hour traffic would also operate at undesirable levels.

US 321 Business to US 221 (Urban Section). Capacity on this section of US 321 could be increased up to eight percent with wider lanes and shoulders and turn lanes. As shown in Figure 2-13, these improvements would result in LOS D in all design periods with current traffic volumes. Like the previous section, typical weekday design hour traffic would operate nearly LOS E by 2025. Weekend design hour traffic would operate at undesirable levels.

### ***Ability to Meet the Project's Purpose and Need***

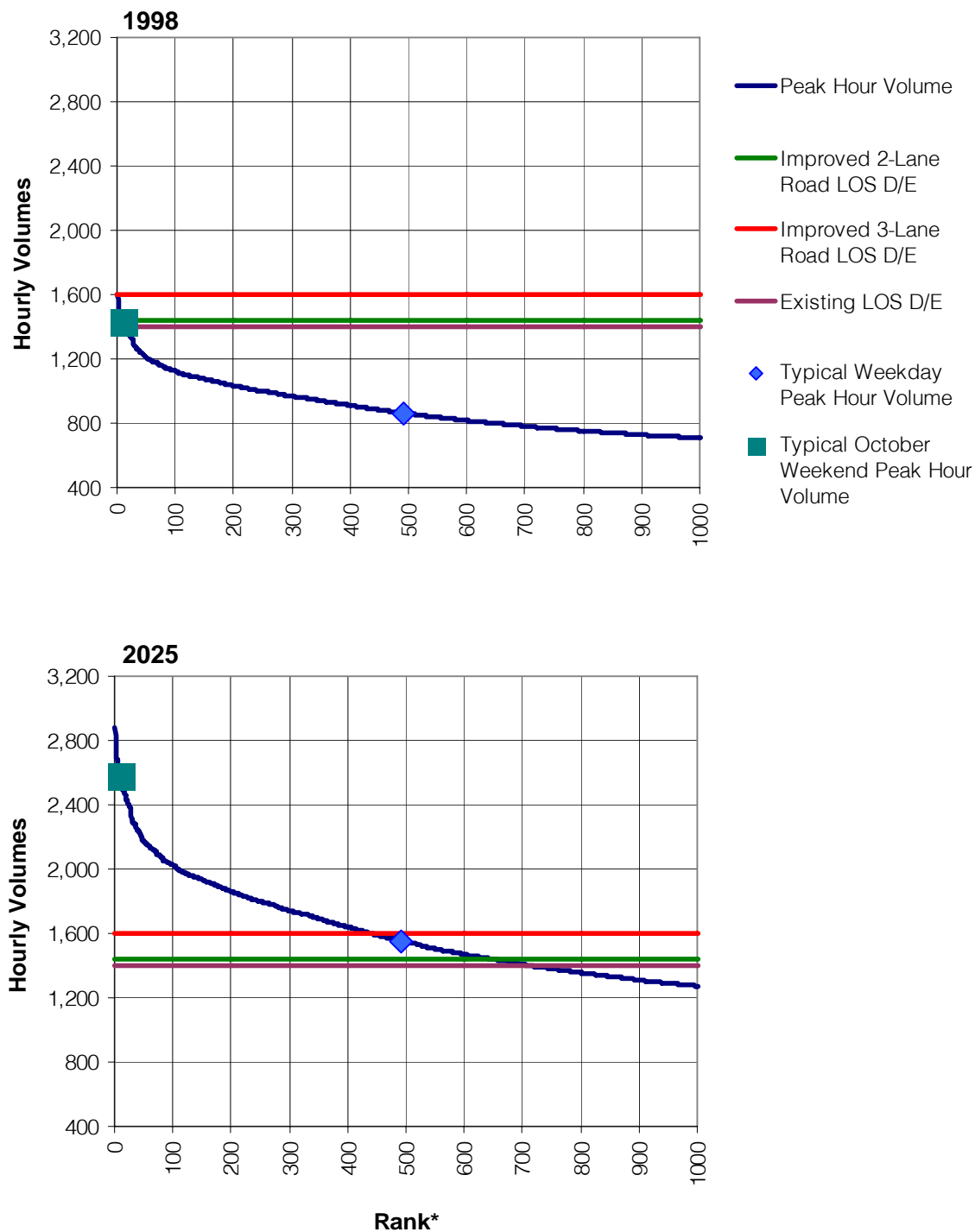
The above analysis found that four lanes would be needed south of Blowing Rock even if one were to lower the benchmark of an acceptable level of service to the average weekday peak period. With an improved two-lane road, a peak hour level of service D would not be achieved in 2025 anywhere in the project area on a typical weekday peak period. With three lanes, the segment between Green Hill Road and US 321 Business would just achieve level of service D during the weekday peak period in 2025. Elsewhere in the project area, typical weekday traffic would be at best level of service E (congested conditions) with three lanes. Because an improved two-lane road and a three-lane road performed poorly even on a typical weekday and therefore worse during October and summer weekend travel peaks, TSM improvements would not meet the purpose of providing an adequate level of traffic service through 2025.

**Figure 2-11. Peak Hour Volume & Capacity  
Blackberry Road to Green Hill Road**



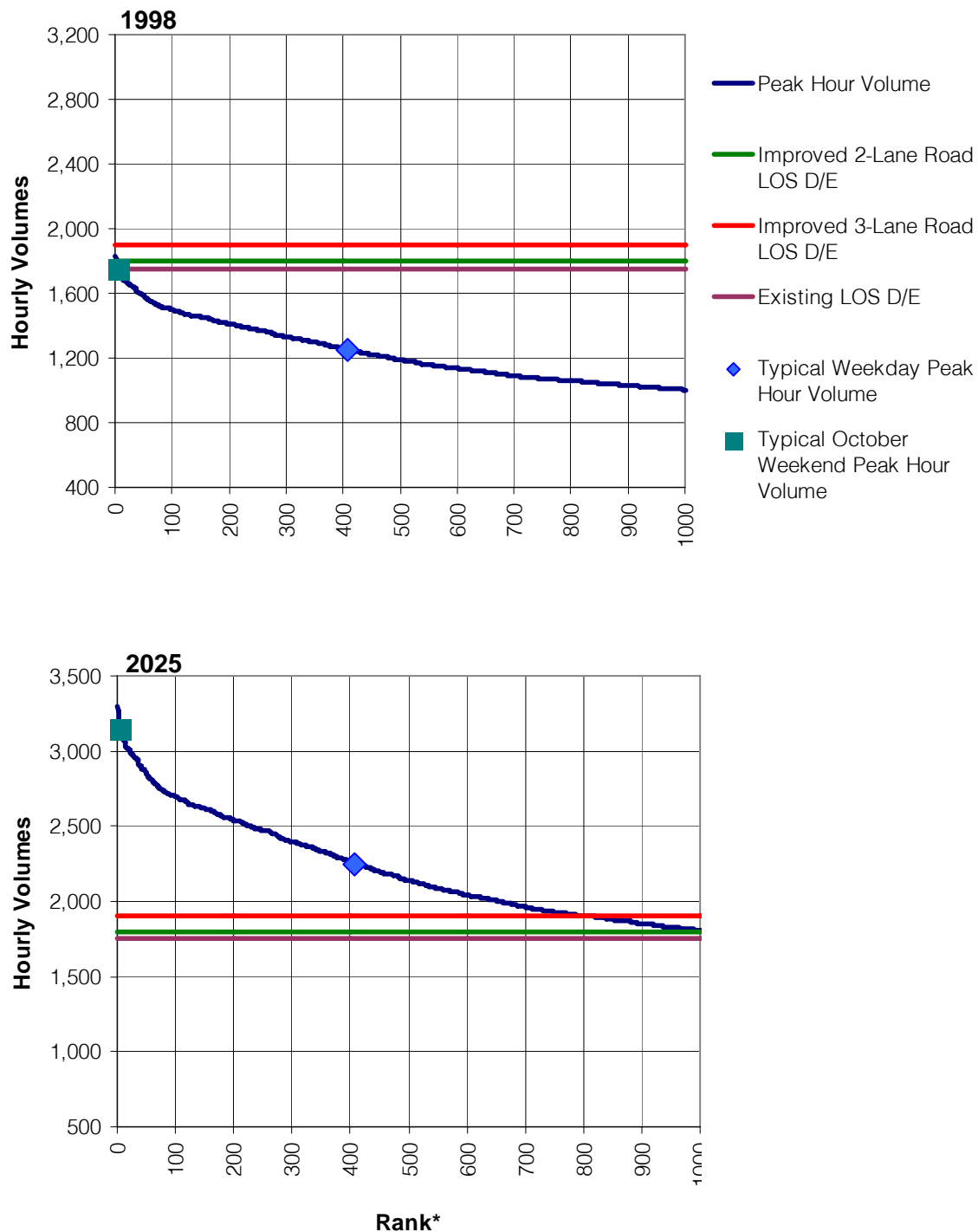
\*Highest peak hour volume to 1000<sup>th</sup> highest peak hour volume

**Figure 2-12. Peak Hour Volume & Capacity  
Green Hill Road to US 321 Business**



\*Highest peak hour volume to 1000<sup>th</sup> highest peak hour volume

**Figure 2-13. Peak Hour Volume & Capacity  
US 321 Business to US 221**



\*Highest peak hour volume to 1000<sup>th</sup> highest peak hour volume

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### 2.3.7 Partial Four-Lane Alternative

In response to comments made at the public hearing that expressed concerns about widening US 321 to four lanes through the Green Park Historic District and Blowing Rock as a whole, a partial four-lane alternative was examined. Two design variations were examined from a traffic operations perspective. These two design variations were:

- One-lane in each direction and a landscaped median with left turn lanes on US 321 from Green Hill Road to south of Pinnacle Avenue and
- One-lane in each direction and a landscaped median with left turn lanes from Green Hill Road to Sunset Drive.

These two partial four-lane design configurations assumed that a four-lane US 321 would be provided north and south of these segments. These configurations were analyzed to determine how well they would perform in terms of meeting geometric, traffic capacity, truck operations, and safety requirements.

#### ***Capacity Analysis***

Methodology and Assumptions. The Widening Alternative with the two design variations were modeled using the Synchro-SimTraffic model (Version 5.0). The Synchro part of this model utilizes the capacity analysis methodology for signalized and unsignalized intersections developed as part of the 2000 *Highway Capacity Manual* (Transportation Research Board, 2000). The SimTraffic component takes the Synchro model input and simulates the operation of each vehicle through the roadway network and collects delay and other operational statistics such as queues. The analysis of the two design variations used the same estimated capacity to carry traffic that was used in the TSM Alternative analyses discussed in Section 2.3.5. Peak period or design hour traffic assumptions used in this analysis were the same as in the other level of service (LOS) analyses presented in this FEIS.

Link level of service was determined using a combination of Florida LOS and Highway Capacity Manual methodologies. The Florida LOS methodology is tool with capacity principles similar to Highway Capacity Manual. It is used because the Highway Capacity Manual -based capacity analysis methodology for urban arterials does not include two-lane urban arterials with design speeds less than 50 mph, which is the case for the two design variations in the urban segment of US 321.

Link Level of Service. Table 2-5 shows the 2025 link LOS for the Widening Alternative, with the two design variations, through the Historic District for four road segments. The LOS comparison shows that the design variations would worsen link-level traffic operational conditions to unacceptable levels of LOS E and F.

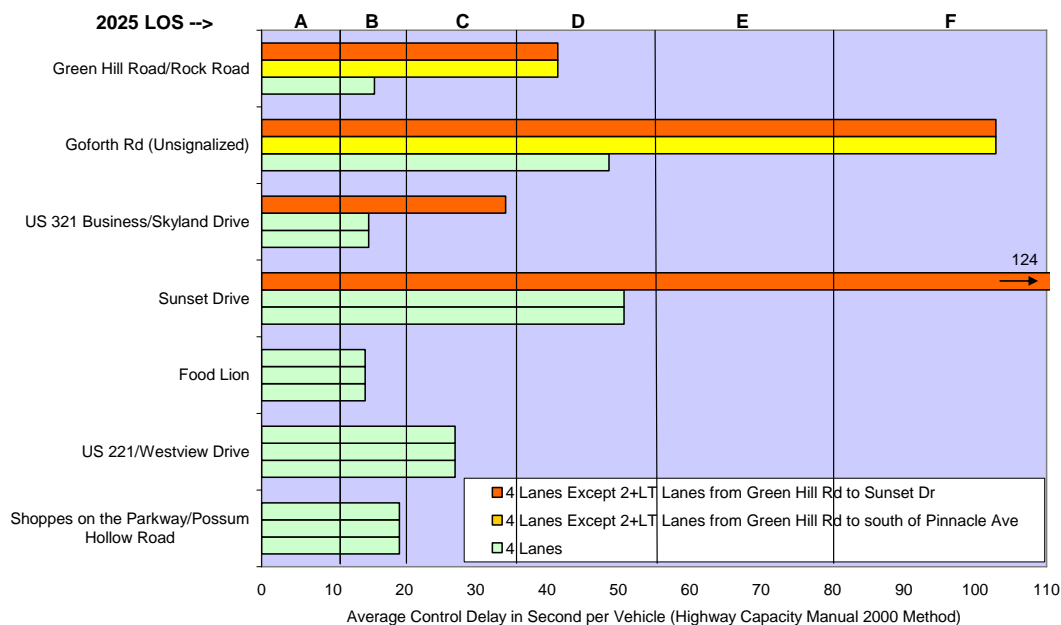


**Table 2-5. 2025 Link Level of Service (LOS) for Partial Four-Lane Designs**

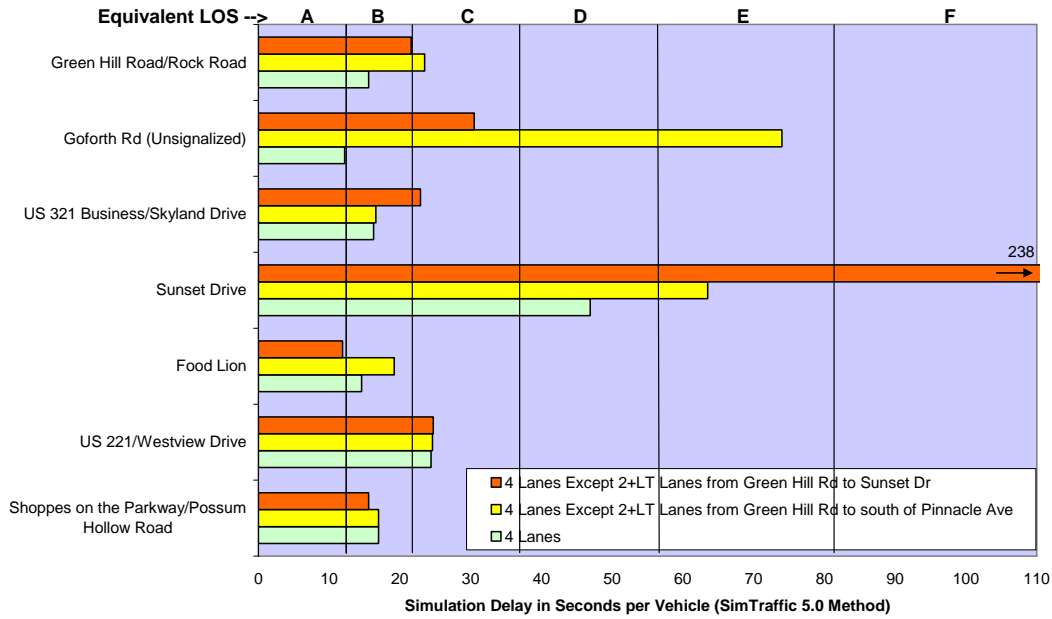
US 321 Link	Widening Alternative	Two Lanes with Left Turn Lanes
South of Blackberry Condominiums	B	F
Blackberry Condominiums to-Green Hill Road	B	F
Green Hill Road-Goforth Road	C	E / F
Goforth Road-US 321 Business	C	E / F

Intersection Level of Service. The 2025 intersection LOS results for the Widening Alternative with the two design variations are shown in Figure 2-14 for six signalized intersections and one unsignalized intersection along US 321. The LOS results in Figure 2-14 are based on Synchro's 2000 *Highway Capacity Manual* analysis results, where each intersection was analyzed based on isolated operational conditions. In contrast, Figure 2-15 depicts LOS results for the same seven intersections derived from a traffic simulation run using SimTraffic, where operation of one intersection could affect nearby intersections. In both analyses, the Green Hill Road intersection shows worsening traffic conditions with the two design variations, generally up to LOS D. The LOS deficiency (LOS F) at the Goforth Road intersection is only for the minor street and not applicable to traffic along US 321. In addition, the Memorandum of Understanding with the Town of Blowing Rock presented in Appendix G makes closing the Goforth Road intersection a part of the Preferred Alternative. The two-lane with left turn lanes design from Green Hill Road to Sunset Drive would cause a substantial bottleneck at the Sunset Drive intersection (i.e., LOS F with very high delay).

**Figure 2-14. 2025 Control Delay at US 321 Intersections in Blowing Rock**



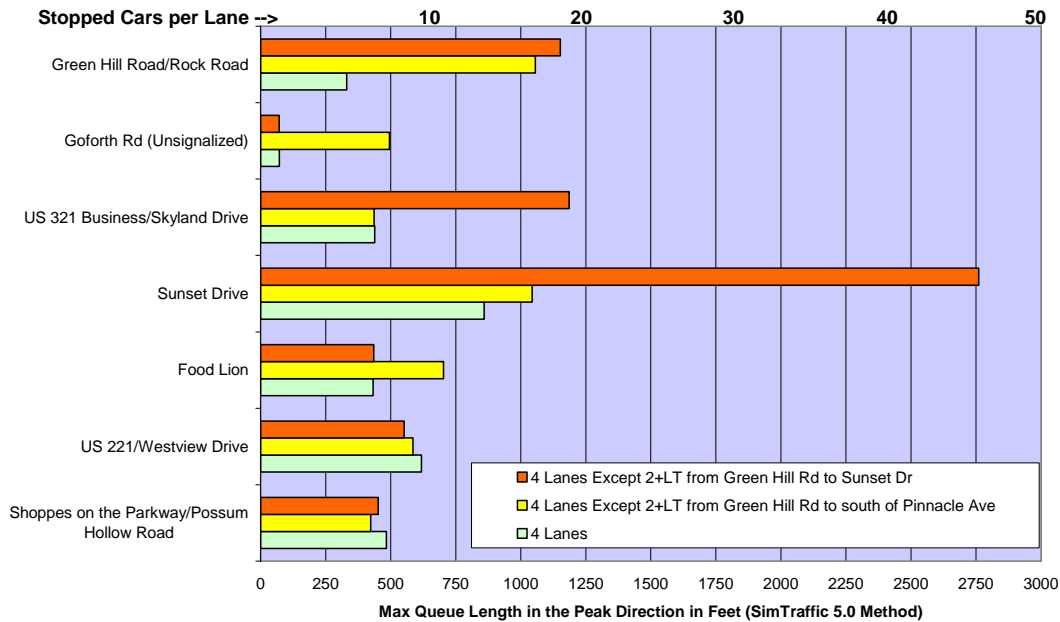
**Figure 2-15. 2025 Network Delay at US 321 Intersections in Blowing Rock**



### Maximum Queues

Figure 2-16 presents the 2025 maximum queue lengths observed at the US 321 intersections using the SimTraffic model. The Sunset Drive and the Green Hill Road intersections would have substantial queuing problems with a two-lane with left turn lanes design.

**Figure 2-16. 2025 Queues along US 321 in Blowing Rock**

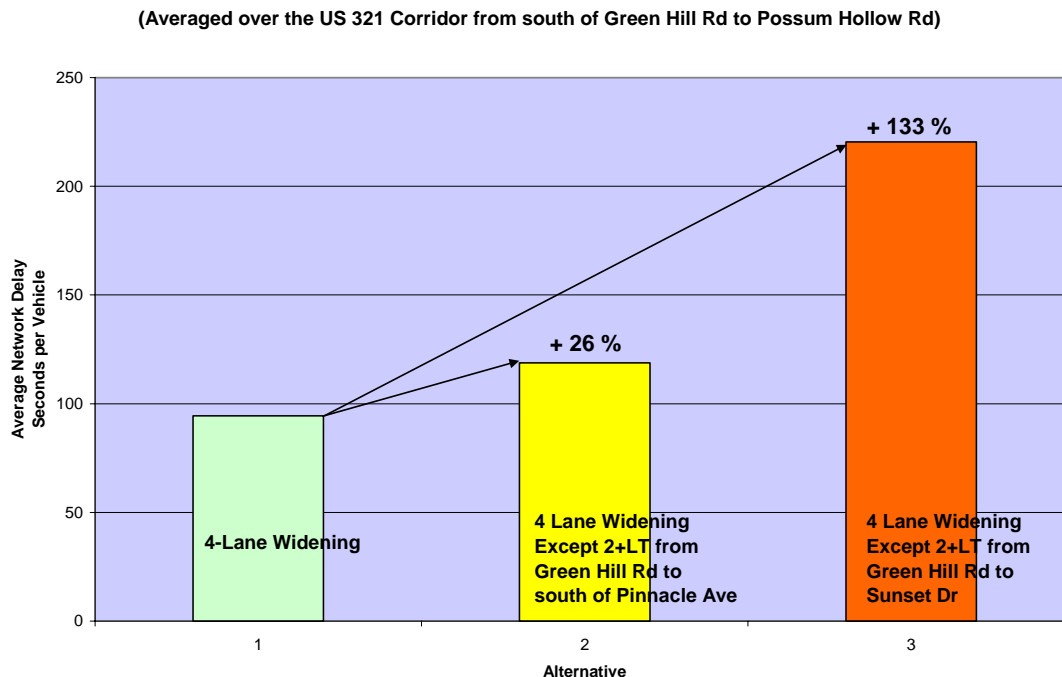


Note: Queue at the Goforth Road intersection is on Goforth Road and not on US 321. Queues at all other intersections represent the maximum queue length along US 321 in the peak direction of travel and were based on one-hour of traffic simulation.

### Urban Corridor Delay

Figure 2-17 depicts the average delay through Blowing Rock for the Widening Alternative and the two design variations. Two lanes with left turn lanes from Green Hill Road to Sunset Drive would increase delay over the four-lane widening by 133 percent, and the shorter two lanes with left turn lanes segment would increase delay by 26 percent.

**Figure 2-17. 2025 Network Delay**



### Geometric Issues

In addition to capacity considerations, two geometric factors also were considered. The factors considered were:

- Impact of grade on truck operations and
- Lane transitions from a four-lane section to two lanes with left turn lanes.

In developing a transition from the four-lane rural section south of Blowing Rock into two travel lanes with left turn lanes at the Green Park Historic District, the seven percent approach grade and the eight percent daily truck volume pose a substantial design challenge. Using the speed-distance curves from the American Association of State Highway and Transportation Officials (AASHTO) manual on design geometrics (AASHTO, 2001), estimates of the average truck speed were developed as shown in Table 2-6.

**Table 2-6. Impact of Grade on Truck Speed**

<b>Location</b>	<b>Average Truck Speed</b>	<b>Grade</b>
Just South of Blowing Rock	20 mph	At end of 7% upgrade of over 8,000 feet and beginning of 3.5% upgrade
Near Blowing Rock Town Limits	25 mph	3.5% upgrade
Near Green Hill Road intersection	30 mph	End 3.5% upgrade and begin 0.7% upgrade
Near Goforth Road	35 mph	Crest of hill, begin 1.5% downgrade

The AASHTO manual identifies several criteria that can justify a truck-climbing lane. The rural segment of US 321 south of Blowing Rock meets the criteria for size of upgrade traffic flow, size of upgrade truck flow, and speed reduction because of the grade or level of congestion.

Safety considerations also would justify the addition of a climbing lane. Studies show that speed deviation is one of the major factors in increasing the likelihood of crashes, as well as their severity. As shown in the AASHTO manual (Exhibit 3-62), the crash rate for specific vehicles can increase by more than ten times for a vehicle with over a 20 mph speed differential with other traffic. For this reason, a truck-climbing lane can improve safety by separating the slower truck traffic from the faster traffic.

According to AASHTO, the ideal design extends a truck climbing lane to a point beyond the crest of the change in grade from steep to shallow, or alternatively to a point at which a truck can attain a speed within 10 mph of the speed of other vehicles. It is recognized, however, that this is not always practical. In such situations, a practical point to end the added lane is where trucks can return to the normal lane without undue interference from other traffic and with sufficient sight distance. For 30 to 40 mph design speeds, a passing sight distance of 1,040 feet is required, with an additional 200 feet of straight road, followed by 200 feet of tapering road, resulting in a total distance of over 1,400 feet of sight distance and transitional road.

Based on this AASHTO criteria, the only place on the corridor to the south of the Green Park Historic District that a truck climbing (or a second northbound) lane could be ended with sufficient sight distance is along the straight part of US 321 south of Blowing Rock in the Cone Orchard Road area (between Stations 640+00 and 655+00 on the design drawings included in Appendix D). However, the US 321 upgrade is also seven percent at this location. Thus, it also meets the criteria for a truck-climbing lane. To end a truck climbing (or second northbound) lane here would therefore create a congestion bottleneck and introduce safety problems on US 321 south of Blowing Rock.

Another option would be to eliminate the truck climbing (or second northbound) lane after the steep grade and the sharp curves have ended, which would be on the straight portion of US 321 within the Green Park Historic District. In this scenario, the transition would not begin until somewhere near Green Hill Road. The transition would end adjacent to the Blowing Rock Country Club golf course, which is well within the Historic District. While this would work from a traffic operations perspective, two northbound travel lanes would be retained through most of the Historic District because of these severe geometric constraints.

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### ***Safety Issues***

Despite the justification for providing a truck climbing (or second northbound) lane south of Green Hill Road, an analysis of the impact of terminating the lane south of the Green Park Historic District was performed, since narrowing the footprint through the Historic District would be the primary goal. The analysis focused upon general design and signing principles in order to determine site-specific safety issues. For the section of US 321 over a 2,000-foot distance south of Green Hill Road, several safety issues occur:

- Severe horizontal curvature and restricted sight distance;
- The interaction of trucks and automobiles through mountainous terrain and curves; and
- Safety at the Green Hill Road intersection.

With regard to the Green Hill Road intersection, the two-lane with left turn lane design variations would be likely to increase the potential for rear-end crashes at the Green Hill Road intersection because of the long queues that would be anticipated to occur on the northbound approach and that would extend to the curves in US 321 south of Green Hill Road (see Figure 2-16).

Safety at the Green Hill Road intersection may be further compromised by the complex merging and acceleration decisions that would be required from different vehicle types. Trucks would be expected to accelerate and merge into oncoming traffic if there were a lane drop at Green Hill Road (or alternatively cars would merge into accelerating truck traffic), which would likely cause unsafe lane merging operations at the intersection.

Although signing could be provided to alert drivers to the upcoming lane drop, traffic signal, and low speed curves, it is unlikely that adequate sign spacing is available to sign properly for all three of these operational conditions. In addition, trucks could substantially restrict the visibility of signs to drivers in the left lane. The introduction of overhead signing would improve sign visibility, but would still not be adequate to resolve operational concerns.

### ***Ability to Meet the Project's Purpose and Need***

Based on the above analysis it is concluded that a partial four-lane alternative with two lanes with left turn lanes in parts of Blowing Rock would pose substantial safety and operational issues in the future and thus not meet the project's purpose and need. Specifically:

- Queues would increase substantially at the signalized intersections along US 321;
- The two-lane with left turn lane sections would operate at a congested LOS E or F;
- A truck climbing (or two northbound) lanes would be required for operational safety south of Blowing Rock;
- A distance of 1,400 feet would be needed to transition from a truck climbing (or two northbound) lanes to a single northbound lane with left turn lanes;
- Only two places exist where a climbing lane could possibly be terminated. One of these locations would be on a seven percent grade, which would undermine the effectiveness of the climbing lane and would cause a bottleneck, and the other would be in the Green Park

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Historic District, which would fail to realize the primary benefit of eliminating the fourth lane, which is to minimize the road's footprint in the historic district;

- The anticipated travel speed differential between trucks and cars would increase the probability of crashes in the transition area; and
- The anticipated long queue at the Green Hill Road intersection with the associated road curves south of the intersection would increase the potential for rear-end crashes and affect truck acceleration.

## **2.4 Description of Build Alternatives, Including the Preferred Alternative**

This section describes the characteristics of the Build Alternatives evaluated in Chapter 4, including the Preferred Alternative. For each alternative, the following is addressed: key design criteria, design characteristics, final design opportunities, construction period procedures and options, and ability to serve the project's purpose and need. The cost for each alternative and permit requirements are discussed at the end of this section.

The Preferred Alternative is the Widening Alternative, which calls for widening existing US 321 to four lanes. On January 15, 2003, the NCDOT met with state and federal environmental resource and regulatory agencies. This group (the Merger Team), with one Merger Team member agency (the State Historic Preservation Office) abstaining, identified the Widening Alternative as the Least Environmentally Damaging Practicable Alternative (LEDPA) for US 321 improvements in Blowing Rock (see Section 7.10.1 of Chapter 7). This identification of the LEDPA and the NCDOT's selection of the Widening Alternative as the Preferred Alternative considered each alternatives' ability to meet the project's purpose and need, environmental consequences, opportunities available to mitigate impacts, cost, public and agency comment on the findings of the DEIS, and other findings presented in the DEIS and this FEIS.

The designs and the associated landscape plans for each Build Alternative are included in Appendix D. One design was developed for the Preferred Alternative, and two designs were developed for each of the two bypass corridors described in Section 2.2. These alternatives are described in the paragraphs that follow.

In order to identify the location of specific design features, the text occasionally refers to "station" numbers. The drawings in Appendix D show these numbers along the preliminary centerline of each alternative. The station numbers indicate roadway length in hundreds of feet. For example, the distance between stations 635 and 640 is 500 feet. The distance between stations 635 and 640+50 is 550 feet.

### **2.4.1 Preferred Alternative**

The Preferred Alternative would widen existing US 321 from Blackberry Road through the Town of Blowing Rock to Possum Hollow Road from two lanes to four lanes. Curves would be flattened south of Blowing Rock and in the Norwood Circle and Country Club Drive area of Blowing Rock. The project would include a four-lane section with shoulders south of the Blowing Rock town limits; a four-lane section with curbs and gutters and some turn lanes in Blowing Rock south of US 321 Business; and four lanes with a landscaped median north of US 321 Business. Several intersections also would be improved.

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### ***Key Design Criteria***

**Roadway.** Design criteria for all Build Alternatives would be in accordance with NCDOT and AASHTO standards. For the Preferred Alternative, these criteria vary in four distinct segments as shown in Table 2-7. The Preferred Alternative's design criteria are based on its two functional classifications: 1) rural arterial south of the Blowing Rock town limits and 2) urban principal arterial north of the town limits. The typical cross sections for the Preferred Alternative are illustrated in Figure 2-18.

**Cut and Fill Slopes.** The terrain of the project area necessitates either cuts (excavation) from the hillsides or fills into valleys. Slope criteria for the project were developed based on the 1998 geotechnical survey described in Section 2.1.3 and on experience gained from other construction projects in the area. All of the Build Alternatives would use 2:1 fill slopes (increase in height of 1 foot (0.3 meter) for every 2 feet of horizontal distance). The only exception to that criterion is at the southern end of the project where the Build Alternatives would use a 1.75:1 slope to avoid creating a large fill at Blackberry Road. Cut slopes would be 1.75:1 when the cut is less than 20 feet high. Cut slopes greater than 20 feet high, would have slopes between 1.5:1 and 1.75:1. The location where each type of cut slope was allowed was specified by the Geotechnical Engineering Unit of the NCDOT. These overall slopes provide space for steeper 0.5:1 to 1.5:1 rock cuts with a 30-foot wide catchments area at base and a 30-foot wide bench at transition from rock to soil. The slopes that would be used during final design would be based on a soil and rock drilling program to identify the depth of soil and more specific rock characteristics.

**Retaining Walls.** Because of the steep terrain of the project area, retaining walls are an integral design characteristic of all the Build Alternatives. They would be used primarily to avoid or minimize impacts to sensitive resources or neighborhood communities. Types of walls included in the designs of the Build Alternatives are identified later in Table 2-8.

**Bridges.** No bridges are proposed for the Preferred Alternative. Streams would be crossed by extending existing culverts.

**Other Design Assumptions.** Current and proposed development was considered in developing the Preferred Alternative, including reducing impacts to the Green Park Historic District, the proposed Blowing Rock Performing Arts Center, a planned Blowing Rock fire and emergency response facility, and a development proposed at the intersection of US 321 and US 221.

### ***Design Characteristics***

The designs described below and evaluated in this document are included in Appendix D. Some of the features described below are specifically discussed in a Memorandum of Understanding between the Town of Blowing Rock and the NCDOT and the Section 106 Memorandum of Agreement (see Appendix G).

**Lane Location.** From Blackberry Road to the Gideon Ridge, the new pavement would be on the west to avoid fills into the valley on the east. In the Gideon Ridge area, the pavement would be widened to the east to avoid affecting the Green Park Historic District and cuts into Gideon Ridge. Within the Green Park Historic District, the pavement would be widened to the west to avoid impacts to the Green Park Inn and the fourth hole fairway and green of the Blowing Rock Country Club. Between the fourth hole fairway and the intersection of US 321/US 321

**Table 2-7. Key Design Criteria for the Build Alternatives**

Design Element	Preferred Alternative				Bypass Alternatives			
	From Blackberry Road to Gideon Ridge Area	From Gideon Ridge Area to Just South of Green Hill Road	From Just South of Green Hill Road Through the Green Park Historic District	From the intersection of Business US 321 to Possum Hollow Road.	1A	1B	4A	4B
Design Speed	50 mph	50 mph	40 mph	40 mph	50 mph	50 mph	50 mph	50 mph
Posted Speed	45 mph	45 mph	35 mph	35 mph	45 mph	45 mph	45 mph	45 mph
Lane Width	12'	12'	11'	12'	12'	12'	12'	12'
Shoulder Width	10'	–	–	–	10'	10'	10'	10'
Curb and Gutter Width	–	8' with Berm	8' with Berm	8' with Berm	–	–	–	–
Median Width	4' (flushed/painted)	0'	0'	16'	4' (flushed/painted)	4' (flushed/painted)	4' (flushed/painted)	4' (flushed/painted)
Maximum Radius of Curves:	6° 45'	6° 45'	11° 00'	11° 15'	6° 45'	6° 45'	6° 30'	6° 30'
Minimum Stopping Site Distance	400'-475'	400'-475'	275'-325'	275'-325'	400'-475'	400'-475'	400'-475'	400'-475'
Maximum Grade	7.00%	7.00%	10.00%	10.00%	7.00%	7.00%	7.48%	7.48%



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**Figure 2-18. Preferred Alternative Typical Sections  
(Part A)**

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**Figure 2-18. Preferred Alternative Typical Sections  
(Part B)**

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**Table 2-8. Retaining Wall Design Criteria**

Type of Retaining Wall	Primary Use	Maximum Height
Rock and soil anchor walls	Used primarily for cuts	70 feet
Mechanically stabilized earth walls (MSE)	Used primarily for fills	None
Gravity Walls	Used for retaining walls less than 8 feet	< 8 feet

Business, the roadway would be widened east of the existing road centerline to reduce existing curvature. From the intersection of US 321/US 321 Business to Sunset Drive the new pavement would be to the east. North of Sunset Drive, some new pavement would be on the west to reduce cuts into the hillside.

Curve Improvements. The horizontal curves east and south of Gideon Ridge would be improved, to the extent permitted by the project area's severe terrain although several would remain exceptions to the project's design criteria. Exceptions to the curve criteria would occur south of Green Hill Road and south of US 321 Business also. This means that the design speed of the Preferred Alternative would be lower at these locations than the design criteria recommended. In general, the exceptions to the design criteria were made in order to avoid additional earthwork and right of way acquisitions and to avoid impacts to the Green Park Historic District. Curves in the Country Club Drive and Norwood Circle area would be improved to meet the project's curve criteria, increasing sight distances for motorists turning onto and off US 321.

Intersection Improvements and Signalization. All intersections with US 321 would remain at-grade. Stop signs would be placed on the cross streets of unsignalized intersections. The improvements are identified in Table 2-9. They include adding traffic signals at the intersections with Green Hill/Rock Road, US 321 Business, and the Food Lion entrance. Traffic studies show that a signal may not be warranted at the Food Lion entrance initially but would be needed by 2025. A coordinated traffic signal system would be installed. An emergency median crossover would be provided at a new fire/emergency medical service station planned by the Town of Blowing Rock for US 321 between Church Street and Sunset Drive.

Left turn lanes were considered at Country Club Drive and Norwood Circle. In order to provide a left turn lane at both intersections, a continuous five-lane section would be required between the Pinnacle Avenue area and US 321 Business. At these two intersections, the proposed four lanes would provide adequate capacity for forecasted left turns and through volumes without left turn lanes. The Preferred Alternative would include gentler curves than exist today and cleared shoulders and, thus, sight distances would be improved. Widening the road to four lanes is in keeping with the NCDOT objective of finding a balance between the traffic flow and safety objectives of the project and protecting the village character of Blowing Rock. However, while persons turning at Norwood Circle would have the option of reaching their destination from an improved Skyline Drive/US 321 intersection, Country Club Drive destinations do not have a second point of access to US 321. A left turn lane can be included at Country Club Drive alone with only a small amount of additional right-of-way, and thus, it is included in the Preferred Alternative.

At the Green Park Inn, guests regularly cross US 321 between the Inn and its parking area on the opposite side of the road. This parking area no longer belongs to the Green Park Inn. The Green Park Inn is allowed to use the parking by the current property owner. This lot would not be replaced. The US 321/Goforth Road intersection north of the Inn would be permanently closed.

**Table 2-9. Location and Purpose of Intersection Improvements  
with the Preferred Alternative**

Street/Road	Purpose of Improvement	Improvement
Rocky Knob Road	Geometric improvement and relocation	Construction of a "T" style intersection
Cone Orchard Lane	Geometric improvement and relocation	Construction of a "T" style intersection
Rock Road/Green Hill Road	Capacity	Signal and left turn lanes (on US 321 and Green Hill Road)
Goforth Road	Requested by the Town of Blowing Rock	Closure
Country Club Drive	Turning improvement	Left turn lane on US 321
US 321 /US 321 Business/Skyland Drive	Geometric and capacity improvement	Creation of a four-legged intersection, signal, and left turn lanes (on US 321 Business, Skyland Drive, and US 321)
Ransom Street	Access	Left turn lane on US 321
Sunset Drive	Capacity	Left turn lane on eastbound Sunset Drive
Road at Station 779+50 (Blowing Rock Community Arts Center)	Geometric improvement	Left turn lane on US 321
Food Lion entrance	Geometric improvement and capacity	Left turn lane on US 321 and signal
US 321/US 221/Westview Drive	Geometric improvement and capacity	New signalized intersection created 600 feet south of existing intersection for the purpose of creating adequate separation between this intersection and the US 321/Possum Hollow Road/Shoppes on the Parkway intersection
Possum Hollow Road/Shoppes on the Parkway	Geometric Improvement	Widened with right turn lanes

Retaining Walls. Eleven retaining walls are proposed with the Preferred Alternative. Their location and characteristics are shown in Table 2-10. Retaining walls would be of formed concrete with a simulated masonry surface treatment designed to simulate the existing stone walls in the Green Park Historic District.

Earthwork. The NCDOT seeks to balance the amount of cut and fill material generated and used by each alternative. Table 2-11 lists the amounts of cut and fills material required for the Preferred Alternative by segment. The bulk of the excavation would occur near SR 1373 (Rocky Knob Road). The bulk of the fill material would be required east of the last major curve at Gideon Ridge before entering the Blowing Rock corporate limits. The Preferred Alternative is anticipated to require approximately 40,000 cubic yards of borrow (excess fill material). Geotechnical drilling during final design could provide more information about subsurface conditions and perhaps allow for steeper cuts in rock at some locations.

Control of Access. There would be no control of access along the Preferred Alternative. Existing driveway connections to US 321 would be retained or replaced. The existing emergency access for The Pines residential subdivision would be replaced.

Fog. Mechanisms for increasing safety and improving driver behavior during fog occurrences would be evaluated and included in the project as recommended by the NCDOT Traffic Engineering Branch and after review by the Town of Blowing Rock and the State Historic Preservation Office.

**Table 2-10. Retaining Walls Included in the Preferred Alternative**

Station Number <sup>1</sup>	General Location	Height Range (ft) <sup>2</sup>	Purpose
618+50 – 620+00	Rocky Knob Road	6.0 – 11.0	Allow for widening US 321 toward Rocky Knob Road
651+00 – 655+00	Gideon Ridge	7.0 – 22.5	Eliminate large fills
655+50 – 658+00	Gideon Ridge	5.0 – 14.5	Eliminate large fills
692+00 – 698+00	Golf Course	1.5 – 7.0	Provide for an 8-foot wide flat area or berm adjacent to the curb
696+50 – 597+50	A.G. Jonas Cottage	2.4 – 5.3	Reduce impact to historic property.
711+50 – 714+00	Norwood Circle	9.5 – 22.5	Eliminate large fill
716+50 – 717+00	North of Norwood Circle	4.0	Eliminate impact to property
736+00 – 738+50	Day's Inn	2.5 – 5.0	Avoid encroachment onto existing parking lot
772+00 – 775+00	Bollinger-Hartley House	3.5 – 12.5	Avoid historic property
786+50 – 789	US 221	7.0 – 17.0	Avoid impact to lake by the realignment of US 221
793+50 – 795+00	Shoppes on the Parkway	1.5 – 2.5	Avoid impacts to stream

<sup>1</sup> Station locations are to the nearest 50 feet. The station numbering is that on the drawings included in Appendix D.

<sup>2</sup> Retaining wall height is to the nearest 0.5 foot.

**Table 2-11. Cut and Fill Requirements for the Preferred Alternative**

Station <sup>1</sup>	Excavation (yd <sup>3</sup> )	Fill (yd <sup>3</sup> )
581+00 to 600+00	85,386	45,815
600+00 to 630+00	530,103	26,018
630+00 to 660+00	7,422	150,993
660+00 to 672+00	30	525,948
672+00 to 690+00	17,654	16,652
690+00 to 720+00	50,577	8,438
720+00 to 750+00	39,383	6,918
750+00 to 780+00	23,258	8,598
780+00 to 800+00	<u>15,627</u>	<u>7,457</u>
<b>Total</b>	769,440	796,837

<sup>1</sup>The station numbering is that on the drawings included in Appendix D.

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**Sidewalks, Parking, Guard Rail, and Utilities.** The Preferred Alternative would include sidewalks on both sides of US 321 between US 321 Business and Possum Hollow Road and on the east side of US 321 from Green Hill/Rock Road to US 321 Business. When guard rail is required, a wood-faced guard rail would be used unless it is found to unsatisfactorily increase the area disturbed by the project. In Blowing Rock between Green Hill/Rock Road and Possum Hollow Road, utilities would be placed underground. Above ground utilities (power, telephone, cable, etc.) would be placed into an underground conduit bank on one side of the proposed alignment. Sewer and water lines within this area would be placed in a utility corridor on the side of the road opposite the power (etc.) conduit. Other utilities in conflict with the proposed alignment would be relocated as needed.

**Landscaping.** A landscaping plan would be developed and implemented. Existing stone walls removed would be replaced in kind. A median would be included in the road between US 321 Business and Possum Hollow Road. It would be either vegetated or decorative concrete, according to the Town of Blowing Rock's preference. Decorative pedestrian lamps would be placed along the road at selected locations in Blowing Rock. Broad areas of landscaping would be included along the road where right-of-way, roadway elements, terrain, and safety conditions allow. Efforts would be made to preserve trees of identified to be of particular value by the Town of Blowing Rock. The project would include development of a park in the unused right-of-way left from the relocation of the US 221/US 321 intersection.

**Design Coordination with the Town of Blowing and Others.** The NCDOT would coordinate with the Town of Blowing Rock on final design features. The Town would be given the opportunity to review and comment on the design plans at three stages of their development (approximately 25 percent when horizontal and vertical alignments are complete; 50 percent when drainage, construction limits, right of way, and easements are defined; and 80 percent just prior to finalizing the plans). The Town of Blowing Rock also would be given the opportunity review and comment on: the surface treatment for retaining walls and decorative concrete medians, preliminary traffic control plans, preliminary signing plans, preliminary pavement marking plans, and preliminary post-construction landscape plans. These same opportunities would be given to the State Historic Preservation Office. These preliminary plans would be available for review at the Blowing Rock Town Library.

### ***Cost***

The Preferred Alternative and landscaping features would have the following costs:

	<i>DEIS Cost</i>	<i>FEIS Cost</i>
Right-of-Way	\$23,400,000	\$23,400,000
Construction	\$22,500,000	\$30,500,00
TOTAL	\$45,900,000	\$53,900,000

The FEIS construction cost is in 2005 dollars and reflects increases in construction costs for transportation projects statewide since the costs presented in the DEIS were prepared. The right-of-way cost has not been revisited since the DEIS.

### ***Construction Period Procedures and Options***

**Sequence of Operations.** Following is general discussion of possible ways to handle the challenges of constructing the Preferred Alternative. It is provided as an example of what could occur based on typical approaches to road construction. NCDOT has made commitments to the Town of Blowing Rock and the State Historic Preservation Office for mitigating impacts during the construction period (see Section 4.16 of Chapter 4 and Appendix G). Additional, more

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detailed construction procedure planning, would be done during final design and the development of contractor documents.

Before construction begins, the contractor would secure one or more staging area(s) and mobilize its equipment, fuel and water tanks, and field office. The existing NCDOT salt storage facility south of Blowing Rock is one potential staging area for all of the alternatives. The contractor may seek to secure multiple staging area(s) by approaching private landowners for additional sites. No staging areas or construction offices would be located in the Green Park Historic District.

The construction sequence would begin with clearing, installing erosion control devices, and clearing initial earthwork areas. During the clearing phase, the contractor would likely proceed concurrently with structure demolition (demolition of buildings that are taken as part of right of way acquisition and are in conflict with construction). The next step would be earthwork operations (which would involve blasting) and installation of storm sewer pipe and structures. The contractor would sequence any required utility relocations to accommodate earthwork operations.

Utility relocation for the Preferred Alternative would likely be the most challenging construction element. Strategies for accomplishing this work are discussed in Section 4.14 of Chapter 4.

The contractor would sequentially construct half of the new roadway in sections, shift traffic onto the newly completed half sections, and construct the remaining half. The following is a potential section-by-section phasing of construction of the Preferred Alternative. The actual phasing would be determined by the contractor, guided by final design and NCDOT contractor documents. The designations of “left” and “right” refer to the lanes and shoulders on either side of the center of the widened roadway as observed by a motorist traveling northbound on US 321. “Short closures” is defined as approximately 20 minutes. The station numbering is that on the drawings included in Appendix D.

- Section 1, Station 581+00 to 591+00

Side hill fill to right, switch traffic to right two new lanes, small cuts to left, final grade and pave.

- Section 2, Station 591+00 to 595+00

Side hill cut (shallow) to right, switch traffic to right on two new lanes, cut to left, final grade and pave.

- Section 3, Station 595+00 to 604+00

Uphill cut to left; if soil cut, use pilot car with one lane operation (alternating one-way traffic that is controlled by one or more dedicated vehicle(s) that lead(s) public traffic through the work zone) during contractor working hours for approximately 6 weeks; if rock blasting, use short closures for blast and muck removal over a period of approximately ten weeks; final grade and pave.

- Section 4, Station 604+00 to 606+50

Fill depression to left, final grade and pave.

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- Section 5, Station 606+50 to 611+00  
Rock cut left, short closures for blast and muck removal, final grade and pave.
  - Section 6, Station 611+00 to 621+00  
Cut left for Rocky Knob Road, which transitions to mainline cut, short closures for blast and muck removal, final grade and pave.
  - Section 7, Station 621+00 to 623+50  
Fill to left, final grade and pave.
  - Section 8, Station 623+50 to 628+00  
Cut to left, short closures for blast and muck removal, final grade and pave.
  - Section 9, Station 628+00 to 635+00  
Reconstruct on existing level area adjacent to the existing roadway, traffic switches between existing lanes and new lanes to construct one side at a time.
  - Section 10, Station 635+00 to 638+00  
Construct temporary pavement left within the existing right-of-way, move traffic left, construct fill to right, final grade and pave.
  - Section 11, Station 638+00 to 640+50  
Reconstruct on existing roadway platform, traffic switches between existing lanes and new lanes to construct one side at a time.
  - Section 12, Station 640+50 to 648+00  
Move traffic as far left as practical on the existing pavement section, construct fill to right, final grade and pave.
  - Section 13, Station 648+00 to 651+00  
Reconstruct on existing roadway platform, traffic switches between existing lanes and new lanes to construct one side at a time.
  - Section 14, Station 651+00 to 658+00  
Construct wall to the right, final grade and pave.
  - Section 15, Station 658+00 to 660+00  
Excavate rocky knob to the right, short delays to remove muck.



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- Section 16, Station 660+00 to 685+00

Construct side hill fill to right, move traffic to right, fill on existing left side, final grade and pave.

- Section 17, Station 685+00 (Rock Road) to Station 697+00

Construct walls, reconstruct on existing roadway platform, traffic switches between existing lanes and new lanes to construct one side at a time.

- Section 18, Station 697+00 to Station 731+00 (Ransom Street)

This is a tight area. The existing roadway meanders across the new alignment at multiple locations and there is insufficient shoulder width adjacent to the existing roadway to accommodate efficient construction without a lane closure. Thus, this section would require 0.64-mile (1.03 km) long pilot car operation during working hours for approximately five to ten months (depending upon the time of year when the contractor commenced the operation) to allow reconstruction on existing roadway platform one side at a time. The one-lane pilot car operation is needed to provide space for equipment and because the new and old roadways are at different elevations.

- Section 19, Station 731+00 to 765+00

Construct the new northbound lanes, move two-way traffic onto the completed northbound lanes, construct retaining wall and fills to the left, final grade, and pave.

- Section 20, Station 765+00 to 785+00

This also is a very tight section, particularly with the rock cut (right) below the Cliff Dwellers Inn at Station 783+00. To construct section 20 without a detour, the contractor would need approximately four to five months using short closures to blast and remove muck. An option would be to allow a detour during construction from US 321 to Main Street to Ransom Street to Sunset Street back to US 321. This would allow expeditious rock excavation and construction to the right in about six weeks or less. It would, however, bring US 321 traffic through a residential area. The contractor would provide local access for businesses and residences along the detoured section of US 321. The detour option would enhance safety by providing more distance between motorists and the blast zone. A decision on such trade-offs would be made with the Town Council of Blowing Rock with input from citizens. : If a decision is made to restrict traffic detours on this stretch of Main Street, it must be carefully articulated in the contractor documents (bid package). NCDOT will discuss this matter with the Town of Blowing Rock during the final design development to decide on appropriate restrictions to include.

In evaluating the possible sequencing of these sections, the linear nature of highway construction needs to be considered. Sections are identified as areas that have similar characteristics of roadway construction and traffic handling. To produce a project that is economical to construct, a contractor would need to work several adjacent sections concurrently. As the planning and design process continues, these individual sections would be merged into an overall construction phasing strategy that best addresses the project goals.

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**Timing of Operations.** Construction of the Preferred Alternative would take two to three construction seasons, plus an additional season in advance of road construction to place utilities underground. In the absence of contract controls, the timing of operations is the responsibility of the contractor. The most basic approach to owner control is to monitor the contractor by requiring a detailed baseline construction schedule, methods statement, and monthly schedule updates. For a project of this complexity and because of sensitive community issues, additional contract controls would be imposed by the NCDOT. They would be developed in association with the community officials. They could consider daily, weekly, and seasonal peak periods. They could include requirements through the contract specifications such as maintaining a minimum number of lanes open during certain periods of the day, blasting requirements, and “no disruption of traffic” days for specific community events. They could provide contractor incentives to complete critical operations within a defined window of time. An example of a time restriction would be to prohibit the contractor from working within the right-of-way between 11:00 p.m. and 7:00 a.m. An example of an activity restriction would be to require the contractor to set off explosives (“fire shots” or “shoot”) between the hours of 3:00 p.m. and 4:00 p.m. By setting the window between 3:00 p.m. and 4:00 p.m., the contractor would have the maximum available daylight to prepare for the shot while minimizing disruption to the afternoon commuter period.

**Traffic Control.** The NCDOT would use “Smart Zone” techniques in the maintenance of traffic during construction. Such techniques could include advance notification of delays, lane closures, real time monitoring, and digital messaging systems. Traffic control during construction of the Preferred Alternative also could include: temporary signalization (or temporary adjustments to existing signal timing), pilot and trailing vehicles, and flag persons to handle side street traffic and business/residential driveway access during one-lane operations. The NCDOT would provide preliminary traffic control plans to the Town of Blowing Rock for review and comment before they are finalized.

**Maintenance of Access.** Access to residences and businesses during construction would be maintained. Temporary access to businesses would be signed.

***Ability to Serve the Project’s Purpose and Need***

The average daily traffic forecasts and the design hourly levels of service for the Preferred Alternative are shown in Table 2-12 and Table 2-13, respectively. The design hour is the hour with a traffic volume that represents a reasonable value for guiding design decisions. The hourly volume used to determine the level of service of the US 321 Improvements alternatives (design hour volume) is equal to 14 percent of the average daily traffic. The Preferred Alternative would improve traffic operations along the entire length of US 321 to LOS D or better through 2025. The project would achieve the desired design hour LOS C along the roadway at all locations except between US 221 and Shoppes on the Parkway where an acceptable LOS D would occur. Table 2-14 indicates that the intersections along US 321 would operate at the desirable LOS C in 2025 except at Sunset Drive. The Sunset Drive intersection would operate at LOS C with dual left turn lanes on Sunset Drive for west to northbound movements. However, these are not proposed as part of the project in order to avoid impacts to adjoining land uses. LOS D is acceptable in urban areas.

The Preferred Alternative would help reduce crash potential and increase safety along existing US 321 through more gentle curves and wider lanes. Specific features that would reduce crash potential are:

- Green Hill Road intersection – left turn lane;

**Table 2-12. Average Daily Traffic Forecasts**

Link #	Description	1998	2025			
		Existing	Under No-Build Alternative Scenario	Under Preferred Alternative Scenario	Under Bypass Alternative 1 Scenario	Under Bypass Alternative 4 Scenario
Traffic on Existing US 321						
1	South of New Bypass	7,525	14,100	14,100	14,100	14,100
2	New Bypass-Green Hill Road	7,525	14,100	14,100	3,100	4,300
3	Green Hill Road-Goforth Road	8,925	15,900	15,900	4,000	6,050
4	Goforth Road- US 321 Business	9,525	16,900	16,900	5,150	7,150
5	US 321 Business-Sunset Drive	10,000	17,400	17,400	6,900	7,000
6	Sunset Drive-Food Lion Driveway	12,300	21,300	21,300	11,750	10,200
7	Food Lion Driveway-US 221	12,750	21,200	21,200	12,600	10,400
8	US 221-Shoppes on the Parkway	15,350	27,450	27,450	19,300	17,400
9	North of Shoppes on the Parkway	14,525	26,150	26,150	26,150	16,250
9a	Blue Ridge Parkway to Bypass	–	–	–	–	16,075
9b	North of Bypass	–	–	–	–	24,700
Traffic on New Bypass						
10	US 321-Possum Hollow Road	–	–	–	12,300	10,400
11	Possum Hollow Road-Forest Lane	–	–	–	12,850	10,400
12	Forest Lane-US 321	–	–	–	13,000	10,400
13	US 321-US 321	–	–	–	–	10,400

**Table 2-13. Design Hour Level of Service<sup>1</sup>**

Link #	Description	1998	2025			
		Existing	No-Build Alternative	Preferred Alternative	Bypass Alternative 1	Bypass Alternative 4
US 321						
1	South of New Bypass	E	F	B	B	B
2	New Bypass-Green Hill Road	E	F	B	D	D
3	Green Hill Road-Goforth Road	D	F	C	B	C
4	Goforth Road- US 321 Business	D	F	C	C	D
5	US 321 Business-Sunset Drive	C	F	C	C	C
6	Sunset Drive-Food Lion Driveway	D	F	C	D	C
7	Food Lion Driveway-US 221	D	F	C	E	D
8	US 221-Shoppes on the Parkway	C	E	D	C	E
9	North of Shoppes on the Parkway	B	C	C	C	B
9a	Blue Ridge Parkway to Bypass	–	–	–	–	B
9b	North of Bypass	–	–	–	–	C
New Bypass						
10	US 321-Possum Hollow Road	–	–	–	B	A
11	Possum Hollow Road-Forest Lane	–	–	–	B	A
12	Forest Lane-US 321	–	–	–	B	A
13	US 321-US 321	–	–	–	–	A

<sup>1</sup>Design hour traffic equals 14 percent of Average Daily Traffic

**Table 2-14. Design Hour Intersection Level of Service**

Intersection	1998	2025			
	Existing	No-Build Alternative	Preferred Alternative	Bypass Alternative 1	Bypass Alternative 4
<b>US 321 Intersections</b>					
Green Hill Road (Unsignalized)	D	F*	–	A	C
(Signalized)	–	–	B	–	–
Goforth Road (Unsignalized)	C	F	closed	A	B
US 321 Business (Unsignalized)	F	F*	–	C	D
(Signalized)	–	D <sup>1</sup>	B	B <sup>1</sup>	B <sup>1</sup>
Sunset Drive (Signalized)	C	F*	D	F	F
Food Lion (Unsignalized)	F	F*	–	F	F
(Signalized)	–	–	B	B <sup>1</sup>	B <sup>1</sup>
US 221 (Signalized)	B	F*	C	B	D
Shoppes on the Parkway (Signalized)	B	F*	B	C	C
<b>Bypass Intersections</b>					
Bypass/US 321 South Terminus (Signalized)	–	–	–	B	B
Bypass/Possum Hollow Road (Unsignalized)	–	–	–	F	–
Bypass/Forest Lane (Unsignalized)	–	–	–	–	–
Bypass/North Terminus (Signalized)	–	–	–	C	B

For unsignalized intersections – “(F)” indicates the worst movement LOS

F\* indicates level of service worse than F and V/C (volume/capacity ratio) greater than 1.2.

<sup>1</sup> Not a part of this alternative but could be installed as a part of a minor improvement project

- Road section that includes intersections with Pinnacle Avenue and Country Club Road – gentler curves with improved sight distance and left turn lane at Country Club Drive;
- US 321 Business intersection – left turn lanes; realignment of intersection and Skyland Drive; traffic signal; combined driveway for three land uses near the intersection;
- Sunset Drive – intersection widened; and
- Possum Hollow Road/Shoppes on the Parkway signalized intersection – US 221 intersection moved further away.

Geometric improvements such as these have been found in other settings to reduce the number of crashes approximately 22 to 25 percent. (FHWA, 1982 and Kentucky Transportation Center, 1996).

#### **2.4.2 Bypass Alternatives 1A and 1B**

Two design options, named Bypass Alternatives 1A and 1B, were developed for the Bypass Alternative 1 corridor. The major difference between the two options is that Alternative 1B includes a cut at Gideon Ridge, which would eliminate the existing sharp curves that do not meet the project’s horizontal curve criteria. Bypass Alternatives 1A and 1B would follow the current US 321 roadway between Blackberry Road and Gideon Ridge. They would then follow along

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Green Hill, cross under Green Hill Road, and pass through the east part of Blowing Rock. They would rejoin US 321 at the Possum Hollow Road intersection. The bypass would have four 12-foot lanes and a 4-foot painted median. The alternative assumes that no improvements are made to existing US 321 north of its southern intersection with the bypass.

### ***Key Design Criteria***

The typical cross sections for Bypass Alternatives 1A and 1B are illustrated in Figure 2-19. Both a roadway and bridge typical cross section are shown. Roadway design criteria are shown in Table 2-7. Cut and fill slopes and retaining walls would follow the same criteria described for the Preferred Alternative. Efforts were made to balance the amount of material excavated from cuts with the amount of material needed for fills.

### ***Design Characteristics***

The designs described below and evaluated in the EIS are included in Appendix D.

Location. This alternative would follow existing US 321 from Blackberry Road to Gideon Ridge. All horizontal curve exceptions present along the existing roadway up to the Blackberry Condominiums would be eliminated. This is achieved by decreasing the cuts into the existing terrain and increasing the fills on the east side of the road. North of the Blackberry Condominiums, Bypass Alternative 1A leaves two curves that do not meet the horizontal design criteria. Bypass Alternative 1B eliminates those curves via a deep cut into Gideon Ridge. North of Gideon Ridge, Bypass Alternatives 1A and 1B leaves existing US 321 and begin a side hill route along Green Hill. The alternatives follow the ridge to Green Hill Road and turn to the northwest crossing underneath Green Hill Road. Green Hill Road would pass over the bypass on a bridge. The alternatives continue north, crossing Wonderland Wood Drive and Wonderland Drive on a bridge. They pass under Goforth Road at the entrance to the Blowing Rock Assembly Grounds and rejoin US 321 on the north at the present intersection with Possum Hollow Road.

Intersections and Other Road Crossings. Alternatives 1A and 1B would affect several existing roads and intersections. Table 2-15 describes the proposed changes. The bypass would not intersect with any local roads between US 321 on the south and Possum Hollow Road on the north.

Bypass Alternatives 1A and 1B rejoin US 321 at and Possum Hollow Road. The majority of the traffic on the bypass would be making a right-turn onto US 321 toward Boone. Traffic volumes on US 321 north and south of the intersection would be greater than those on the bypass. Thus, the bypass would intersect existing US 321 in a manner that requires bypass users coming from the north or going north to turn to and from the bypass. The US 221 intersection with US 321 would be moved south to avoid traffic congestion and increase safety.

Retaining Walls and Bridges. Several retaining walls would be included in Bypass Alternatives 1A and 1B. They are described in Table 2-16.

Bypass Alternatives 1A and 1B would include four bridges. One bridge would take US 321 over an unnamed tributary of the Yadkin River as the bypass leaves existing US 321 and one bridge would span Wonderland Drive and Wonderland Wood Drive. The other two structures would carry Green Hill Road and Goforth Road. Table 2-17 identifies the bridges included in Bypass Alternatives 1A and 1B.

Earthwork. Table 2-18 presents the amounts of cut and fills material associated with Bypass Alternatives 1A and 1B. Bypass Alternative 1A would require extensive fill south and east of

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**Figure 2-19. Bypass Typical Sections**

**Table 2-15. Intersections and Other Road Crossings with Bypass Alternatives 1A and 1B**

Road	Proposed Change
Rocky Knob (SR 1373)	Realignment with US 321.
Cone Orchard Road	Small shift in the roadway with US 321 to the southeast.
Gideon Ridge Road	No change with Bypass Alternative 1A; section removed with Bypass Alternative 1B.
Blackberry Condominiums	No substantial change with Bypass Alternative 1A; Access to the south via a then-former section of US 321 with Bypass Alternative 1B.
Existing US 321	Existing US 321 would intersect the bypass at a signalized “T” intersection.
Green Hill Road	Green Hill Road would be relocated slightly to the north and pass over the bypass on a bridge. The intersection of Fairway Court and Green Hill Road would be shifted to the west.
Wonderland Drive	The bypass would pass over Wonderland Drive on a bridge.
Goforth Road	Goforth Road would pass over the bypass on a bridge. The intersection of Goforth Road and the Blowing Rock Assembly Grounds driveway/entrance would be relocated.
Forest Lane	Forest Lane would intersect the bypass at-grade.
Hughes Road	Hughes Road would be realigned and intersect the bypass at-grade.
Possum Hollow Road	Possum Hollow Road would intersect the bypass at-grade 1,800 feet from its intersection with US 321. The bypass would replace Possum Hollow Road from this point to the end of the project.
US 321	The bypass would end at a four-legged signalized intersection with the Shoppes on the Parkway driveway. Travelers would make a turn to enter the bypass. This configuration is the only one that would allow the intersection to meet a LOS C in 2025.
US 221	The US 221 signalized intersection would be moved in the same manner as the Preferred Alternative in order to achieve LOS C in 2025 at both the US 221 and the Shopped on the Parkway/bypass intersections.

**Table 2-16. Retaining Walls Included in Bypass Alternatives 1A and 1B**

Station Number <sup>1</sup>	General Location	Height Range (ft) <sup>2</sup>	Design	Purpose
630+50 – 632+50	Former salt bin south of Blowing Rock	1.0 – 4.5	1A & 1B	Avoid Green Park Historic District
634+50 – 635+00	Just north of former salt bin south of Blowing Rock	19.0 – 21.0	1A & 1B	Avoid Green Park Historic District
649+00 – 656+50	Blackberry Condominiums	2.0 – 27.0	1A	Minimize fills
664+00 – 667+00	Between Blackberry Condominiums and town limits	1.5 – 21.5	1A	Avoid impacts to a neighborhood
669+50 – 672+00	Between Blackberry Condominiums and town limits	12.5 – 35.5	1B	Minimize fills
672+00 – 687+50	Side of Green Hill	1.0 – 60.0	1B	Minimize cuts
674+50 – 678+50	Side of Green Hill	7.5 – 37.0	1A	Minimize fills
676+00 – 689+50	Side of Green Hill	3.0 – 49.5	1B	Minimize fills
677+00 – 696+00	Side of Green Hill to Green Hill Road	5.5 – 60.0	1A	Minimize cuts and impacts to homes
680 – 688+50	Side of Green Hill	3.5 – 46.5	1A	Minimize impacts
688+50 – 696+00	Side of Green Hill to Green Hill Road	8.5 – 67.0	1B	Minimize cuts
695+50 – 701+00	Green Hill Road	20.0 – 48.5	1A & 1B	Reduce length of Green Hill Road bridge
751+50 – 755	Possum Hollow Road	4.5 – 22.0	1A & 1B	Eliminate impacts to stream
758+00 – 764+00	Possum Hollow Road	19.5 – 41.5	1A & 1B	Minimize impacts to properties along Forest Lane

<sup>1</sup> Station locations are to the nearest 50 feet. The station numbering is that on the drawings included in Appendix D.

<sup>2</sup> Retaining wall height is to the nearest ½-foot.

**Table 2-17. Bridges Included in Bypass Alternatives 1A and 1B**

Beginning Station <sup>1</sup>	Bridge Length (ft.)	Alternative	Comments
668+50	575	1A	Crosses unnamed creek and avoids fill
655+00	1,350	1B	Crosses unnamed creek, eliminates major curve, avoids fill
696+00	180	1A	Green Hill Road crosses over US 321
696+00	240	1B	Green Hill Road crosses over US 321
713+50	400	1A, 1B	Bridge over Wonderland Drive, Wonderland Wood Drive, and Middle Fork
736+00	215	1A, 1B	Goforth Road crosses over US 321

<sup>1</sup>The station numbering is that on the drawings included in Appendix D.



**Table 2-18. Cut and Fill Requirements for  
Bypass Alternatives 1A and 1B**

Station <sup>1</sup>	Excavation (yd <sup>3</sup> )	Fill (yd <sup>3</sup> )
<i>Bypass Alternative 1A</i>		
581+00 to 600+00	123,856	51,584
600+00 to 630+00	325,342	300,962
630+00 to 660+00	35,195	288,790
660+00 to 690+00	41,704	461,918
690+00 to 720+00	417,665	41,641
720+00 to 750+00	413,977	46,001
750+00 to 772+00	<u>107,213</u>	<u>49,116</u>
<b>Total for 1A</b>	1,464,952	1,240,012
<i>Bypass Alternative 1B</i>		
581+00 to 600+00	123,856	51,584
600+00 to 630+00	325,342	300,962
630+00 to 637+50	5,684	49,061
637+50 to 660+00	667,313	129,785
660+50 to 678+50	100,144	7,699
685+00 to 690+00	4,374	20,047
690+00 to 711+50	348,275	3,666
711+50 to 720+00	8,527	49,731
720+00 to 750+00	413,977	46,001
750+00 to 772+00	<u>107,213</u>	<u>49,116</u>
<b>Total for 1B</b>	2,104,705	707,652

<sup>1</sup>The station numbering is that on the drawings included in Appendix D.

Gideon Ridge. The majority of the excavation would occur north of Green Hill Road and the majority of the fill would occur south of Gideon Ridge. Bypass Alternative 1A is anticipated to produce approximately 250,000 cubic yards of waste material.

Bypass Alternative 1B would require extensive excavation through the majority of the corridor while requiring moderate fill north of Gideon Ridge. Bypass alternative 1B is anticipated to produce approximately 1.4 million cubic yards of waste material. Hauling this much material off-site would require approximately 155,000 trips. A disposal location is close proximity to the project would be required.

Control of Access. Intersections with existing roads would be maintained at grade. Access to the bypass would be controlled from the point where the bypass leaves existing US 321 on the south until it returns to US 321 on the north.

Gideon Ridge Tunnel for Bypass Alternative 1B. A tunnel to avoid and minimize community impacts associated with the deep cut into Gideon Ridge. Portal location criteria used in siting the tunnel include a soil cover of 25 to 30 feet and a minimum of 20 feet of rock cover over the tunnel crown. These assumptions result in an excavation depth of 70 to 80 feet. These assumptions would place the south portal between station 651+00 and station 651+50 shown on

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the design drawings included in Appendix D and the north portal at approximately station 654+00. Overall length portal-to-portal would be in the range of 250 to 300 feet. Very little of the deep cut north of station 646+00 would be eliminated. Therefore, the possible benefits of a tunnel from the perspective of community impact avoidance do not exist. Excavation for portal construction at either end of the short tunnel also would be extensive and the right of way would have to be widened as the tunnel is approached, increasing the height of sidehill cut. An alternative approach would be to build a straight road from approximately station 636+00 to approximately station 671+00. This approach, however, would require a sidehill cut within the limits of the Green Park Historic District.

### ***Cost***

Bypass Alternatives 1A and 1B and landscaping features would have the following costs (2001 dollars):

	<i>Bypass Alternative 1A</i>	<i>Bypass Alternative 1B</i>
Right-of-Way	\$24,500,000	\$25,200,000
Construction	<u>\$50,600,000</u>	<u>\$67,000,000</u>
TOTAL	\$75,100,000	\$92,200,000

### ***Final Design Opportunities***

In creating the design assessed in the EIS for Bypass Alternatives 1A and 1B, the engineering and landscape architecture team made some decisions, including the components of the re-vegetation plan described in Section 2.4.4, that, if one of these alternatives were selected as the preferred alternative, could be re-visited based on public comment and coordination with local officials. In addition, geotechnical drilling could provide more information about subsurface conditions and perhaps allow for steeper cuts in rock at some locations.

### ***Construction Period Procedures and Options – Bypass Alternative 1A***

Following is general discussion of possible ways to handle the challenges of constructing Bypass Alternative 1A.

Sequence of Operations. As with the Preferred Alternative, construction would begin with staging, clearing, structure demolition, and then earthwork and utility relocations. For the section at the south end of the project that follows the existing road for approximately 1.4 miles, the contractor would follow the same construction sequence as with the Preferred Alternative, by sequentially constructing half of the new roadway in sections, shifting traffic onto the newly completed half sections, and constructing the remaining half. Final efforts would include grading outside the completed pavement sections, guardrail installation, pavement markings, signalization, seeding, and landscaping.

Building the new Green Hill Road Bridge over Bypass Alternative 1A would be a straightforward effort. The contractor would construct the new Green Hill Road/Fairway Court connection and also construct temporary paving in this area so that traffic could continue to use existing Green Hill Road outside the area of the proposed bridge. The contractor would then construct the new bridge and approaches outside of traffic and then connect the new bridge approaches to the existing roadway carrying traffic.

The new Bypass Alternative 1A bridge over Wonderland Drive and Wonderland Wood Drive could be constructed with a minimal effect on existing traffic. The contractor would construct the

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north and south abutments and piers, then hold Wonderland Drive and Wonderland Wood Drive traffic for short closures while setting girders. Once the girders are set, the contractor would deck the bottom girder flanges to prevent construction debris from falling onto the two roadways. Bridge deck construction would then proceed without interrupting traffic.

The most challenging area of construction would be at Goforth Road over Bypass Alternative 1A because the cut for Bypass Alternative 1A would create the clearance for Goforth Road to pass over Bypass Alternative 1A. The construction sequence would be to construct the new Assembly Road connection to Goforth Road, improve the “west branch” of the Assembly Road connection, and then detour Goforth Road traffic onto Assembly Road and the new connection. This would allow the contractor to take down the cut for Bypass Alternative 1A and construct the Goforth Road bridge. If a detour using this short section of Assembly Road were not feasible, then the contractor would need to maintain traffic on Goforth Road while cutting the Bypass Alternative 1A mainline to grade. If the cut at the crossing of Bypass Alternative 1A and Goforth Road requires blasting, the contractor must detour Goforth Road traffic.

Independent of the challenge of maintaining traffic during construction of the Goforth Road bridge, Bypass Alternative 1A is almost all in cut north of Goforth Road. This means that the contractor would need to haul cut material along the Bypass Alternative 1A alignment across Goforth Road (or the Goforth Road detour described above) to fills at the south end of the project, thus adding construction earth hauling equipment traffic to the Goforth Road area. An option would be to truck this cut material on existing US 321 through Blowing Rock. The advantage of this option would be that haul equipment would not have to cross Goforth Road or a detour of Goforth Road. The disadvantage would be the addition of truck traffic through town on existing US 321. The construction contract should address whether earthwork trucking on existing US 321 would be permissible and under what conditions. Based on the preliminary design, approximately 250,000 cubic yards of excavated material would have to be moved from north of Goforth Road to the south end of the project.

Construction along Possum Hollow Road would progress with half section construction, with the contractor first placing cuts and fills outside the existing roadway section to the new grade, shifting traffic onto the new half section, and then completing the final half section and associated fills. The sequence of operations for Bypass Alternative 1A improvements to existing US 321/US 221 would be the same as for the Preferred Alternative.

Timing of Operations. The discussion under the Preferred Alternative is applicable to Bypass Alternative 1A. Bypass Alternative 1A would be in essentially a residential corridor. Accordingly, the contractor’s schedule would be managed to minimize the impacts to the community while taking advantage of the sections of Bypass Alternative 1A that are on new alignment where traffic disruption is a concern only at road crossings.

Traffic Control and Maintenance of Access. Traffic control along Bypass Alternative 1A is a different management challenge than the Preferred Alternative. Bypass Alternative 1A would essentially traverse residential developments. Much of the contractor’s maintenance of traffic operations would be to control earthwork hauling equipment’s crossings of residential roadways. With the cut material at the north half of the project and the fills at the south half, the contractor would be hauling north to south across Forest Lane, Goforth Road, Wonderland Drive, Wonderland Wood Drive, Fairway Court and Green Hill Road. The bridges would be built early to facilitate earthwork operations in the corridor. School traffic and mail deliveries would play a large role in influencing the approach used.

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### ***Construction Period Procedures and Options – Bypass Alternative 1B***

Following is general discussion of possible ways to handle the challenges of constructing Bypass Alternative 1B.

Bypass Alternative 1B is identical to Bypass Alternative 1A except in the Gideon Ridge cut south of the Town of Blowing Rock. Thus, the sequence and timing of operations and traffic control and maintenance of access issues for Bypass Alternative 1B would be similar to Bypass Alternative 1A. Gideon Ridge would likely be an early cut because the contractor could use the material to construct fills on the east side of the existing roadway.

### ***Ability to Serve the Project's Purpose and Need***

Building the Bypass Alternatives 1A or 1B would meet the purpose and need of the project. As shown in Table 2-12, this bypass would attract an average of 12,300 vehicles per day in 2025. Traffic would drop 30 to 78 percent on existing US 321, with the greatest drops occurring south of Sunset Drive. As shown in Table 2-13, a design hour LOS B would occur the full length of the bypass. Improvements to US 321 would, however, be needed to maintain LOS C on existing US 321 between the southern end of the bypass and Green Hill Road (LOS D), Sunset Drive to the Food Lion Driveway (LOS D), and the Food Lion driveway to US 221 (LOS E). LOS D is typically acceptable in urban areas when it is too costly or environmentally damaging to design for a better level of service, but LOS C is preferred.

As shown in Table 2-14, intersections along US 321 would operate at the desirable LOS C in 2025 except at Sunset Drive (LOS F). Improved signal timing and phasing would help lessen the delays, but only geometric improvements to the Sunset Drive approaches before 2025 would improve the intersection to better than LOS F. Two of the unsignalized intersections show a LOS F on the worst leg of the intersection. In both cases, the poor level of service would be on the side street and not US 321 or the bypass. In transportation planning, this is acceptable so long as the overall level of service is LOS C or better.

Bypass Alternatives 1A and 1B would not include road improvements on the existing road (except south of Blowing Rock) that would reduce crash rates. They would reduce, however, traffic on the existing road, reducing the opportunity for crashes. Traffic on the bypass would have the advantage of wider pavement, gentler curves, wider shoulders, only a few intersections, and few opportunities for direct access from adjoining properties. The intersections in the US 221/ Possum Hollow Road/Shoppes on the Parkway area would be improved in a manner similar to the Preferred Alternative.

Bypass Alternative 1A, however, would include a major exception to the project's horizontal design criteria where two sharp curves would remain on a road that otherwise meets the alternative's 50 mph design speed criteria. Although such curves could be marked to warn drivers to slow, their presence would violate the expectations of southbound drivers who would up to that point have experienced mostly gentle curves on the bypass and who would be traveling downhill on a steep (6 percent grade) as they approach these sharp curves. Northbound travelers would be traveling to reach these curves up hill on a 7 percent grade on a generally curvier road similar to what exists today.

## **2.4.3 Bypass Alternatives 4A and 4B**

Two design options also were developed for the Bypass Alternative 4 corridor, named Bypass Alternatives 4A and 4B. The major difference between the two designs is that Bypass Alternative 4B would utilize a greater number of bridges to reduce earthwork, changes in the terrain, natural resource loss, and visual impacts. Both designs would completely bypass the Town of Blowing

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Rock. The alternatives would be almost entirely on new location, crossing a valley at their southern end, following the Blue Ridge escarpment to a tunnel under the Blue Ridge Parkway, following a side hill paralleling Thunder Mountain Road and ending at Aho Road north of the Parkway. The bypass would have four 12-foot lanes and a 4-foot painted median. The alternative assumes that no improvements are made to existing US 321 north of its southern intersection with the bypass.

### ***Key Design Criteria***

The typical cross sections for Bypass Alternatives 4A and 4B are the same as for Bypass Alternatives 1A and 1B and are illustrated in Figure 2-19. Both a roadway and bridge typical cross section are shown. Roadway design criteria again are shown in Table 2-7 and are the same as for Bypass Alternatives 1A and 1B. Cut and fill slopes and retaining walls would follow the same criteria described for the Preferred Alternative. Again, efforts were made to balance the amount of material excavated from cuts with the amount of material needed for fills.

### ***Roadway and Bridge Design Characteristics***

The designs described below and evaluated in the EIS are included in Appendix D.

Location. These alternatives would leave existing US 321 in the Greene Cemetery area, just north of Blackberry Road. They would follow similar but slightly different alignments. These alternatives would have no design exceptions. At their southern end, they would cross a rural valley on a first bridge and then a high fill with Bypass Alternative 4A or a bridge and then a smaller fill with Bypass Alternative 4B. Both would pass below the Blackberry Condominiums to Green Hill. These alternatives would be lower on Green Hill than Bypass Alternatives 1A and 1B. They would then follow the side of the Blue Ridge escarpment below most of the homes that line the top of the escarpment, rising in elevation to a tunnel under the Blue Ridge Parkway. Bypass Alternative 4A would rely mostly on cuts and fills on the escarpment to reach the Parkway with only two bridges in this area. Bypass Alternative 4B would rely on a combination of several bridges and smaller cuts and fills. North of the Parkway, the bypass would pass through a rural area on the side of a hill overlooking Thunder Mountain Road and meet US 321 at Aho Road. Again, Bypass Alternative 4B would rely more on bridges and less on cuts and fills than Bypass Alternative 4A.

Intersections and Other Road Crossings. Unpaved rural roads would be altered with Bypass Alternative 4A and with Bypass Alternative 4B. These changes are shown on the drawings contained in Appendix D. Near the north end, Aho Road would intersect with the bypass. Existing US 321 would end in a “T” intersection at both its intersections with the bypass. Both intersections would be signalized.

Retaining Walls and Bridges. Both alternatives would utilize retaining walls and bridges in order to reduce the environmental and visual impacts. The location and size of the retaining walls required for Bypass Alternatives 4A and 4B are listed in Table 2-19. Alternatives 4A and 4B would both require bridges. Bypass Alternative 4A would have five bridges and Alternative 4B would have 12 bridges. Table 2-20 lists the location and length of each bridge for both design alternatives.

Earthwork. Bypass Alternatives 4A and 4B would be situated in steeper and more rugged terrain than the other Build Alternatives. As a result, Bypass Alternative 4A would have substantially more earthwork. The use of bridges on Bypass Alternative 4B would greatly reduce the total amount of earthwork required to a level similar to that required by Bypass Alternative 1A. Table 2-21 lists the amounts of cut and fill material associated with Bypass Alternatives 4A and 4B. Bypass Alternative 4A as currently designed would produce 91,900 cubic yards of waste. Bypass

**Table 2-19. Retaining Walls Included in Bypass Alternatives 4A and 4B**

<b>Station Number<sup>1</sup></b>	<b>General Location</b>	<b>Height Range (ft)<sup>2</sup></b>	<b>Alternative</b>	<b>Purpose</b>
632+00 – 636+50	Below Blackberry Condominiums	8.5 – 60.0	4A	Minimize cut
649+00 – 651+50	On Blue Ridge escarpment below Green Hill	8.5 – 47.0	4B	Minimize fill
658+50 – 661+00	On Blue Ridge escarpment below Green Hill	28.5 – 50.5	4B	Minimize fill
664+00 – 665+50	On Blue Ridge escarpment below Green Hill	14.5 – 60.0	4B	Fill/cut transition
665+50 – 672+00	On Blue Ridge escarpment below Green Hill Road	16.0 – 60.0	4B	Minimize cut
667+50 – 671+00	On Blue Ridge escarpment below Green Hill Road	2.5 – 60.0	4A	Minimize cut
673+00 – 676+00	On Blue Ridge escarpment below Green Hill Road	1.5 – 52.0	4A	Minimize cut
683+00 – 683+50	On Blue Ridge escarpment below Green Hill Road	7.5 – 13.5	4A	Minimize cut
685+00 – 691+50	On Blue Ridge escarpment below Heather Ridge Lane	8.5 – 60.0	4A	Minimize cut and impacts to residences
687+50 – 694+50	On Blue Ridge escarpment below Heather Ridge Lane	8.0 – 60.0	4B	Minimize cut and impacts to residences
692+00 – 694+00	On Blue Ridge escarpment below Heather Ridge Lane	19.0 – 29.5	4B	Minimize impacts, ties into bridge
696+00 – 699+00	Near south tunnel portal	6.5 – 53.5	4A	Minimize fill
697+00 – 700+00	Near south tunnel portal	8.5 – 45.0	4B	Reduce cut
698+50 – 702+00	Near south tunnel portal	4.0 – 54.5	4B	Minimize fill
716+00 – 724+50	At north tunnel portal	6.0 – 60.0	4A	Eliminate cut into Parkway right-of-way
719+00 – 726+50	At north tunnel portal	9.5 – 60.0	4B	Eliminate cut into Parkway right-of-way

<sup>1</sup> Station locations are to the nearest 50 feet. The station numbering is that on the drawings included in Appendix D.

<sup>2</sup> Retaining wall height is to the nearest 0.5-foot.

**Table 2-20. Bridges Included in Bypass Alternatives 4A and 4B**

Beginning Station <sup>1</sup>	Bridge Length (feet)	Alternative	Comments
<i>Bypass Alternative 4A</i>			
596+00	1,000	4A	Crosses minor roads and small creeks and eliminates fill
651+00	500	4A	Eliminates fill
657+00	600	4A	Eliminates fill
764+00	600	4A	Crosses wetlands and streams
778+50	300	4A	Crosses Middle Fork of the New River
<i>Bypass Alternative 4B</i>			
595+00	1,785	4B	Crosses minor roads and small creeks and eliminates fill
621+50	750	4B	Crosses small creek and eliminates fill
635+50	500	4B	Crosses small creek and eliminates fill
644+50	400	4B	Crosses small creek and eliminates fill
650 – 652+00	600	4B	Minimize fill and cut
671+90	1,120	4B	Crosses small creek and eliminates fill
694+00	350	4B	Crosses small creek and eliminates fill
731+10	500	4B	Crosses small creek and eliminates fill
746+60	1,240	4B	Crosses minor road and small creek
761+00	850	4B	Crosses small creek and wetlands
778+50	300	4B	Crosses Middle Fork of the New River

<sup>1</sup>The station numbering is that on the drawings included in Appendix D.

**Table 2-21. Cut and Fill Requirements for Alternatives 4A and 4B**

Station <sup>1</sup>	Excavation (yd <sup>3</sup> ) <sup>2</sup>	Fill (yd <sup>3</sup> )
<i>Bypass Alternative 4A</i>		
581+00 – 600+00	29,565	81,184
600+00 – 630+00	679,395	999,648
630+00 – 660+00	585,132	670,736
660+00 – 690+00	782,045	447,995
690+00 – 720+00	182,593	476,349
720+00 – 750+00	345,462	231,005
750+00 – 789+00	<u>434,648</u>	<u>40,029</u>
<b>Total for 4A</b>	3,039,840	2,946,946
<i>Bypass Alternative 4B</i>		
581+00 – 600+00	29,622	44,654
600+00 – 630+00	140,666	141,193
630+00 – 660+00	136,215	140,957
660+00 – 690+00	189,325	536,212
690+00 – 703+50	100,230	18,000
719+00 – 750+00	193,800	185,771
750+00 – 780+00	185,920	20,508
780+00 – 789+00	<u>0</u>	<u>13,629</u>
<b>Total for 4B</b>	975,778	1,100,924

<sup>1</sup> The station numbering is that on the drawings included in Appendix D.

<sup>2</sup> Does not include material from excavation of the tunnel.

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Alternative 4B would require 125,000 cubic yards of borrow. If Alternative 4B were selected as the preferred alternative, final design would bring the alternative further into balance.

Access Control. It would be possible to control access from adjoining properties for most of the bypass. Access to adjoining parcels may be required (no other access available) at parcels in rural areas at the southern and northern ends of the bypass. Unpaved rural roads would intersect Bypass Alternative 4A at three locations near its southern end and intersection Bypass Alternative 4B at one location. A final decision regarding access to parcels that would be denied access from the bypass would be determined by NCDOT Division Right-of-Way staff during the preparation of right-of-way plans if one of these alternatives were selected as the preferred alternative.

Utilities. A power substation at Aho Road would have to be relocated.

### ***Tunnel Design Characteristics***

The Bypass Alternative 4 tunnel would include the tunnel, an administration building and emergency vehicle garage near the north portal, and an operations facility at the south portal.

Design Features. The tunnel would consist of two parallel tunnels constructed using controlled blasting methods. Each tunnel would contain two 12-foot wide traffic lanes, a 4-foot partial shoulder, a 2-foot partial shoulder, and an elevated pedestrian walkway. Five cross-passages would be evenly spaced along the tunnel to facilitate the evacuation of vehicle occupants to the adjacent tunnel in the event of an emergency. Closed Circuit Television (CCTV), smoke and heat detectors, and exhaust emission sensors would monitor the tunnel environment. All monitoring information would be continuously displayed in the control room of the Administration Building. A typical tunnel section is shown in Figure 2-19.

Tunnel Ventilation. During normal operating conditions, the tunnel would be self-ventilating. However, mechanical ventilation must be provided for congested conditions and for a fire emergency condition. The governing document is National Fire Protection Association (NFPA) 502, Standard for Road Tunnels, Bridges, and Other Limited Access Highways (NFPA, 1998). Chapter 7 of the Standard requires mechanical ventilation for tunnels with a length greater than 800 feet. The Bypass Alternatives 4A and 4B tunnel, with a portal-to-portal length of 1,500 feet, is subject to this requirement.

The proposed tunnel ventilation scheme is a longitudinal ventilation scheme. This is the most cost-effective ventilation scheme, requiring the minimum tunnel excavation and the minimum size of ancillary buildings. In this ventilation scheme, axial flow fans are installed at intervals along the tunnel. The fans are reversible and pull air and smoke in either direction. The design fire for the Bypass Alternatives 4A and 4B tunnel would be a 20 MW fire (a 20 MW fire is equivalent to a burning motor coach or a large truck). Ten axial flow fans would be required in each tunnel to meet ventilation requirements associated with the design fire. Fans would be installed in pairs at each of the cross-passages. Within the tunnel, spacing between locations of fans and cross-passages would be 300 feet.

Tunnel Staffing and Vehicle Requirements. Requirements for emergency response are contained in Chapter 9 of NFPA 502. Because of its remote location, it is recommended that the tunnel be a manned facility to provide an effective and timely response to emergencies. Further studies of manning requirements would be performed, if either of these alternatives were selected as the preferred alternative.



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Although the tunnel operators would normally report to a higher administrative unit, it is common practice for a tunnel to be a self-contained operational facility, containing on site all personnel required to manage, maintain, and operate the facility and to provide an effective emergency response. This principle has served as the basis for developing an operational plan for the tunnel.

Maintaining the tunnel as a self-contained operational facility would provide the NCDOT with the option of operating the facility itself or retaining an outside contractor to maintain and operate the tunnel.

Because of its remote location, it is recommended that the tunnel be manned 24 hours a day, seven days a week to provide for an effective and timely response to emergencies. Staff requirements are divided into three functional groups: administration, operations, and emergency response and maintenance.

The administration group would consist of three persons who would work a five-day, 40-hour week. The operations and emergency response group would consist of the following job classifications: supervisor (one providing five-day, 40-hour coverage and on call at other times), control room operator (five providing seven-day, 24-hours per day, coverage), and emergency response (nine providing seven-day, 24-hours per day coverage.)

The maintenance group would be required to perform first echelon maintenance and repair of the various mechanical, electrical, and electronic systems necessary to operate the tunnel. A staff of eight persons would be exclusively dedicated to tunnel operation. Although scheduled for a five-day, 40-hour week, maintenance group staff would be on-call 24 hours a day, seven days a week to respond to tunnel emergencies.

Several vehicles also would be necessary to support tunnel operations.

Portal Location. The following factors were considered in selecting the portal locations shown in Appendix D.

- Site geological conditions;
- Portal cut stability;
- Mixed face tunneling; and
- Ground loss.

The combined thickness of colluvium (a soil type), residual soil and saprolite (rock/soil) was assumed to range from 25 feet to 30 feet in thickness. Actual thickness of soil units and the degree of weathering of the underlying bedrock would be evaluated by soil borings if Bypass Alternative 4A or 4B were selected as the preferred alternative.

Instability in portal excavations can result in landslides that would affect facilities or structures upslope of the excavation. Facilities that could be affected by slides at the Bypass Alternatives 4A and 4B tunnel site would include the Blue Ridge Parkway and the Craig Cemetery. Excavations in colluvium, residual soil and saprolite often encounter stability problems. In general, the depth of excavation at the tunnel portal should be minimized to reduce the possibility of stability problems.

Also of importance are the possibilities of mixed-face tunneling conditions and possible ground loss. Mixed-face tunneling is a tunneling operation in which both soil and rock are simultaneously exposed in the excavation face. Mixed-face excavation is the most costly form of

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tunneling because it involves the concurrent use of soil and rock excavation methods in the tunnel. Situations in which both saprolite and rock are exposed in the face would be considered mixed-face tunneling. Given the current state of knowledge of subsurface conditions, some mixed-face tunnel excavation would be expected but the portals were sited to minimize the possibility of mixed face tunneling.

Ground loss is the intrusion of excess material into the excavation. Ground loss can result in surface subsidence and the undermining of surface structures. Ground loss, as its name applies, is the loss of ground at the heading. The heading is the temporary vertical excavation face. Ground loss is often experienced in mixed-face tunneling or when tunneling in weathered rock. On occasion, ground loss at the heading can propagate rapidly in a vertical direction, resulting in subsidence or the development of sinkholes. At the Bypass Alternatives 4A and 4B tunnel site, ground loss could affect the Blue Ridge Parkway, resulting in pavement subsidence or collapse. The most effective way to minimize the potential of ground loss is to increase the effective rock cover at sensitive areas and to reduce or eliminate mixed-face tunneling, often associated with ground loss.

Based on the above considerations, portal location criteria used for the design presented in Appendix D was follows:

- Minimize depth of portal excavation, reducing cost and enhancing stability;
- Minimize length of mixed-face tunneling, reducing cost and risk; and
- Minimize potential ground loss at sensitive locations by increasing rock cover, reducing risk.

Using these criteria, the following portal locations were used in the designs for Bypass Alternatives 4A and 4B:

- A south portal location at approximate station 701+00 for Bypass Alternative 4A on the design drawings included in Appendix D and the equivalent location with Bypass Alternative 4B (703+82). At this location, depth of portal excavation would be approximately 80 feet and total cover above the tunnel crown would be approximately 50 feet. Beyond this point, the ground line begins to rise, increasing portal construction cost and the risk of instability. The 50 feet of total cover at this location also would provide a reasonable degree of confidence that rock tunneling conditions would be encountered at the portal location, with minimum potential for mixed-face conditions.
- A north portal at approximate station 716+00 for Bypass Alternative 4A and the equivalent location with Bypass Alternative 4B (718+82). At this location, depth of portal excavation would be approximately 70 feet and total cover above the tunnel would be approximately 35 feet. Establishing the portal location at this location would result in a total cover above the tunnel crown of approximately 40 feet at the border of the Blue Ridge Parkway. Although some mixed-face tunnel construction is near this portal, the total cover of 40 feet at the Parkway boundary would provide a reasonable degree of confidence that mixed-face conditions would not be encountered when tunneling beneath the Parkway.

Bifurcated Typical Section. Bifurcation was considered as an option for minimizing visual and vegetative impacts of a bypass in the Bypass Alternative 4 corridor. A road is bifurcated when one direction of travel is at a different elevation than the other. A bifurcated typical section is shown in Figure 2-20. A conceptual bifurcated design was developed. It was found that

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**Figure 2-20. Bifurcation Typical Cross Section**

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bifurcation would not reduce the extent earthwork and changes in the terrain needed in this corridor. This situation occurs for two reasons:

- Bifurcation only can be used along the side of the Blue Ridge escarpment. The length of bypass in this area is too short to separate the lanes vertically, bring them back together at the tunnel, and still leave a substantial length of separated roadway.
- The escarpment undulates with ridge lines (peaks) and swales (valleys) emanating from the escarpment. Thus, the bypass is not just following a side hill. It also cuts through ridges and fills or bridges swales. Without a consistent side hill, the escarpment does not lend itself well to bifurcation.

### ***Cost***

Bypass Alternatives 4A and 4B and landscaping features would have the following costs (2001 dollars):

	<i>Bypass Alternative 4A</i>	<i>Bypass Alternative 4B</i>
Right-of-Way	\$9,400,000	\$8,900,000
Construction	<u>\$161,100,000</u>	<u>\$241,400,000</u>
TOTAL	\$170,500,000	\$250,300,000

### ***Final Design Opportunities***

In creating the design assessed in the EIS for Bypass Alternatives 4A and 4B, the engineering and landscape design team made some decisions, including the components of the revegetation plan described in Section 2.4.4, that could be re-visited, were either Alternative 4A or 4B selected as the preferred alternative, based on public comment and coordination with local officials and the National Park Service. In addition, geotechnical drilling could provide more information about subsurface conditions and perhaps allow for steeper cuts in rock at some locations.

### ***Construction Period Procedures and Options – Bypass Alternative 4A***

Following is general discussion of possible ways to handle the challenges of constructing Bypass Alternative 4A. The station numbering is that on the drawings included in Appendix D.

Sequence of Operations. As with the Preferred Alternative, construction would begin with staging, clearing, structure demolition, and then earthwork and utility relocations. Contractor access for equipment mobilization would be challenging with this alternative. There are contractor access points for equipment mobilization at the south end of the alternative via Cone Orchard Lane. Access north on Cone Orchard Lane would be tenuous, with only the potential for the contractor to negotiate access via a vacant or NCDOT-acquired residential lot off Heather Ridge Lane between stations 685+00 and 688+00 and/or via contractor-negotiated access off Heather Ridge Lane between stations 690+00 and 696+50. Because there is a prohibition on trucks on the Blue Ridge Parkway, use of the Parkway to reach Heather Ridge Lane is not an option. Equipment access to Heather Ridge Lane from US 321 in Blowing Rock would be circuitous on narrow roads with tight turns. One possible route would be via Possum Hollow Road, Sunset Drive, Goforth Road, Wonderland Drive, Green Hill Road, and an unnamed connection between Green Hill Road and Heather Ridge Road. The contractor would need specialized haul equipment with a steerable tail end, and other support including pilot cars, flag persons, and police assistance to negotiate the grades and tight curves along this route. In addition, the effort would require close coordination with the public to plan for equipment

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deliveries. Lastly, the NCDOT would plan for pavement repairs along the haul route to repair damage caused by loads that may exceed the existing road capacity.

Once equipment is on site in the Cone Orchard Lane and Heather Ridge Lane areas, the contractor would build a narrow pioneer access road along the bypass alignment for its work force, additional construction equipment, and material deliveries. The “pioneer” access road would start as a logging road suitable only for track equipment, which the contractor would then widen to approximately 20 to 25 feet, with horizontal and vertical curves sufficient to accommodate rock trucks at a maximum speed of 20 miles per hour. Concurrent with the earthwork operations south of Blue Ridge Parkway, the contractor would likely push access along the new alignment from Aho Road to the north portal of the new tunnel so that tunnel construction could start as soon as practicable.

Tunnel construction would be a “critical path” activity. This means that tunnel construction would be an activity that, if delayed, would extend the project completion date. Because of the longer time required to construct the new roadway grade to the south tunnel portal, the tunnel would progress from the north portal only. Accordingly, the contractor would need to accelerate access to the north portal. The best opportunity to accelerate access is for the contractor to use Aho Road to Thunder Mountain Road to the driveway that provides access to a storage shed west of Station 745+00. The driveway branches off Thunder Mountain Road several hundred feet north of the residences that are east of Station 745+00 (opposite the storage shed). From Station 745+00, the contractor would pioneer a road within the proposed right of way to the north tunnel portal. Concurrently, earthwork would start along the Bypass Alternative 4A corridor beginning at US 321 (north terminus) to facilitate the use of the graded bypass to support of the tunneling operation. An alternative but slower approach would be for the contractor to pioneer an access road following the bypass right-of-way from the point it departs Aho Road. This approach would add approximately 5 to 16 months to the construction schedule. The 16-month extension assumes conventional bridge construction for the new bridge from approximately Station 764+25 to 770+25. An alternative technique would be to use precast concrete arches for the bridge. The precast concrete arch design alternative would reduce the bridge construction time and the schedule extension by approximately 11 months down to 5 months.

Timing of Operations, Traffic Control, and Maintenance of Access. The estimated construction duration for Bypass Alternative 4A is four construction seasons. Bypass Alternative 4A would present less interference with traffic and community life during construction than the Preferred Alternative, so the contractor could be afforded more latitude. Restrictions would be considered for the timing of blasting shots, minimizing traffic interference at existing roads on the two ends of the project, and criteria for working within close proximity of Green Hill and other residential locations along the alternative.

#### ***Construction Period Procedures and Options – Bypass Alternative 4B***

Following is general discussion of possible ways to handle the challenges of constructing the Bypass Alternative 4B.

Sequence of Operations. As with the Preferred Alternative, construction would begin with staging, clearing, structure demolition, and then earthwork and utility relocations. Contractor access for equipment mobilization, tunnel construction, and sequencing of work north of the Blue Ridge Parkway for Bypass Alternative 4B would be identical to the access and sequencing of work for Bypass Alternative 4A.

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Bypass Alternative 4B would lend itself to bridge construction using overhead erection techniques, which can be more environmentally benign than conventional methods of bridge construction. However, ground access would be needed to build bridge pier foundations. Equipment access procedures for Bypass Alternative 4B thus would be similar to Bypass Alternative 4A. The route of access roads for Bypass Alternative 4B, because of the extensive use of bridges, could be different from those of Bypass Alternative 4A since the access roads to bridge pier foundations would not need to follow the project alignment. The location and width of these access roads would be influenced by topography, a desire to minimize the extent of access roads, the pier foundation design(s) as driven by geotechnical data, and the type of equipment needed to build the selected pier foundation design. For example, the narrow width of the pioneer access roads used to build Bypass Alternative 4A would be insufficient for constructing drilled shaft (a hole drilled in the ground and filled with concrete and reinforcing steel) pier foundations. A minimum-width pioneer road would neither accommodate the drill rig nor accommodate the volume of concrete delivery trucks needed for drilled shafts.

From a basic access or haul road that would extend through the entire corridor, the contractor would need to construct “finger” access points to construct each substructure element. (The “substructure” consists of the foundations and piers that hold up the bridge spans; the “superstructure” consists of the girders that span the piers and the road deck.) The number, length, width, and location of the finger accesses would vary with the location of the access road relative to the location of the pier element. For example, in locations where the access road could be cut within 40 feet of a pier, the access to the pier would literally be a wide spot in the access road. In other locations where the access road is a greater distance from the pier site, the finger access could switchback for a distance of more than 100 feet from the access road. The finger accesses would likely be a minimum of 25 feet in width to accommodate “rough-terrain” hydraulic cranes to assist in the construction of bridge foundations and piers.

As noted above, the selection of bridge foundation types would influence access road requirements. For example, where piles (a prefabricated foundation element driven into the ground) are an option for certain foundation locations, the likely selection should be steel piles (typically, steel “H” piles or steel pipe piles) rather than concrete piles. The advantage of steel piles is that they can be transported to the foundation location in manageable lengths and welded on location. Concrete piles, by contrast, are considerably heavier, more prone to handling damage, and unsuitable for hard tip, end bearing installations. Drilled shafts may be an option, provided that shaft lengths are less than approximately 60 feet. Shaft lengths greater than approximately 60 feet would pose a severe challenge for handling assembled drilled shaft reinforcing steel cages because of the limited work area at foundation locations. Another potential foundation type would be micro piles. A typical installation of micro piles would be to drill a series of holes approximately 5 to 6 inches in diameter and insert a bundle of reinforcing steel bars. The bar bundles are then grouted in place. The advantage of micro piles is that the contractor uses a rock drill to drill the holes. Rock drills are among the most mobile and versatile pieces of equipment on irregular terrain. Where high bearing capacity rock is shallow (less than 15 feet below existing ground), spread footings may be appropriate. However, spread footings deeper than 15 feet would require an unreasonable amount of shoring to hold the uphill slope above the footing excavation. Spread footings are advantageous in that the reinforcing steel required to construct them would be of manageable dimensions for handling and installation. For locations where there are multiple design options for foundations, the designer would likely develop at least two solutions and afford the contractor the opportunity to select from among them.

Because of the expense and time that would be required to construct bridge foundations along Bypass Alternative 4B, it is crucial to invest sufficient effort in the geotechnical investigations to

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allow the design of foundations that are appropriate for each location. The geotechnical investigation would include a rock core at each pier foundation location, and at least three cores at each abutment (placed where bridges end) – one along the back wall and one for each wing wall.

A pier cap would be cast on top of the piers (columns) to support the superstructure that would likely be cast-in-place concrete.

Bridge construction methods where the superstructure is erected from an adjoining completed bridge span (overhead construction or “top-down” construction) rather than from the ground have been successfully accomplished for decades in the United States. Concrete superstructures using both cast-in-place and precast segmental construction could be appropriate. Erection equipment is available to allow overhead construction on alignments with curvature of up to seven degrees, which is sufficient to accommodate all of the proposed structures on Bypass Alternative 4B. Steel girders also could be used with a cast-in-place concrete deck. These techniques would preclude the need for large crane pads and cranes under the bridge with the associated vegetation and terrain disturbances. Overhead superstructure erection is assumed in the cost estimates for this alternative.

If precast concrete segments are used to build the superstructure, there is a possible concrete batch plant site on existing US 321 within 10 miles from the south end of the project. About 0.75 mile south of the potential batch plant site there is an approximate 7 or 8-acre site that could be used for casting precast elements and storage. It also appears that a railhead exists in Lenoir, crossing Morganton Road, which might be used for delivery of steel girders. Girders would be off-loaded from rail cars and trucked to the site. As the contractor completed substructure elements, superstructure construction would proceed most likely from south to north, followed by approach slabs and deck concrete. Lastly, the contractor would construct parapet walls, tie in guardrails, and apply pavement markings.

Timing of Operations, Traffic Control, and Maintenance of Access. The discussion of this element for Bypass Alternative 4A is also applicable to Bypass Alternative 4B. In addition, it is important to recognize that construction of a large number of bridges would entail a high volume of material and supplier deliveries. The use of precast concrete wall panels, piers, and precast segmental bridge units would eliminate the need for the multiple on-site truck trips necessary to form, reinforce, and place concrete and to remove forms. Trucks carrying precast concrete elements would replace these truck trips. Depending upon the number of bridge erection crews, the contractor could receive as many as 20 to 30 deliveries of precast units per day at the peak of construction, as compared with more than 100 deliveries per day for similar production with cast in place construction. Assuming both a 10-hour workday and evenly spaced deliveries throughout the day, 20 to 30 deliveries per day would mean that a haul truck would be traveling from the casting yard and entering and leaving the site every 20 to 30 minutes. Accordingly, maintenance of traffic at the construction entrance off existing US 321 in consideration of the timing of deliveries would be an important element. Restricting the hours during which the contractor could take delivery of permit loads would be considered.

#### ***Ability to Serve the Project’s Purpose and Need***

Building either Bypass Alternative 4A or 4B would meet the purpose and need of the project. As shown in Table 2-12, this bypass would attract an average of 10,400 vehicles per day (vpd) in 2025. Traffic would drop 40 to 70 percent on existing US 321, with the greatest drops occurring south of Sunset Drive. This bypass would attract less traffic than Bypass Alternatives 1A and 1B because its northern terminus is north of the Blue Ridge Parkway. Thus, traffic traveling between the Parkway and points south would pass through Blowing Rock rather than use the Bypass

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(Alternative 4A or 4B). Also, Bypass Alternatives 1A and 1B would be used by some travelers moving between commercial uses on the north side of Blowing Rock and points south of Blowing Rock. Bypass Alternatives 4A and 4B would not attract this traffic.

As shown in Table 2-13, a design hour LOS A would occur the full length of the bypass. Improvements to US 321 would, however, be needed to maintain LOS C on existing US 321 between the southern end of the bypass and Green Hill Road (LOS D), between Goforth Road and US 321 Business (LOS D), from the Food Lion driveway to US 221 (LOS D), and between US 221 and Shoppes on the Parkway (LOS E). LOS D is typically acceptable in urban areas when it is too costly or environmentally damaging to design for a better level of service, but LOS C is preferred. The one LOS E is a result of heavy volumes on this short segment of US 321 that is encompassed by traffic signals. LOS D on the other segments reflects a need for intersection improvements and the lack of turn bays along existing US 321.

As shown in Table 2-14, intersections along US 321 would operate at the desirable LOS C in 2025 except at Sunset Drive (LOS F) and US 221 (LOS D). Improved signal timing and phasing would help lessen the delays, but only geometric improvements to the Sunset Drive approaches before 2025 would improve the intersection to better than LOS F. One of the unsignalized intersections shows a LOS F on the worst leg of the intersection. This poor level of service would be on the side street and not on US 321 or on the bypass. In transportation planning, this is acceptable so long as the overall intersection level of service is LOS C or better.

Since they would begin just north of Blackberry Road, Bypass Alternatives 4A and 4B would include almost no road improvements on the existing road that would reduce crash rates. Like Bypass Alternatives 1A and 1B, they would reduce the traffic on the existing road, thus reducing the opportunity for crashes. Traffic on the bypass would have the advantage of wider pavement, gentler curves, wider shoulders, only a few intersections, and few opportunities for direct access from adjoining properties.

#### **2.4.4 Landscaping and Revegetation**

Landscape architects prepared the landscape designs illustrated in Appendix D and contributed to engineering design decisions to foster the development of landscape architectural design treatments that would be both functional and aesthetically pleasing. These design treatments incorporate elements of context sensitive design, reflect environmental and community concerns, and include hard (e.g., lights, decorative walls, etc.) and soft landscape elements (e.g., plants). These drawings represent conceptual landscape plans; final landscape plans would be developed closer to project construction and made available to the Town of Blowing Rock for review and comment before they are finalized.

##### ***Design Criteria***

The design criteria for the landscape and replanting plans incorporated applicable elements of the NCDOT's Roadside Environmental Unit's *Guidelines for Planting within Highway Right-of-Way* (NCDOT, no date). The American Association of State Highway and Transportation Officials' *A Guide for Transportation Landscape and Environmental Design* (AASHTO, June 1991) and the FHWA's *Flexibility in Highway Design* (FHWA, 1997) were also consulted during the design process. Design concepts developed by the NCDOT in late 1998 and presented in the March 1999 video also were considered.

The underlying concern of the design was that the roadway design alternatives possess the functional and aesthetic qualities of good roadway design, while providing hard and soft



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landscape elements where warranted, incorporate native plant materials to the greatest extent possible, and reflect the level of perpetual maintenance (do not want to plant what NCDOT is not willing to maintain) to be provided. In addition to providing visual enhancement, the landscape planting design would address slope stabilization, revegetation, and reforestation requirements. To achieve the aforementioned design criteria, a plant materials list, and strategy for each of the alternatives was developed.

A project plant list was developed from the “1994 Tree and Shrub Recommendations for NCDOT Highway Plantings” (NCDOT, 1994d) and the Town of Blowing Rock’s “Lists of Recommended Trees and Shrubs” (Town of Blowing Rock, no date). The plant list includes plant materials that are: 1) from Plant Hardiness Zone 5 or lower, 2) have proven success for inclusion in transportation projects, and 3) are native to the northwest region of North Carolina.

### ***Plant Materials***

The proposed landscape plantings would include 2 to 5 feet tall deciduous trees on the slopes; 1.5 inch caliper deciduous trees on the slopes immediately adjacent to the roadside; and 3-inch caliper trees in flatter areas or areas of prominence. Evergreen trees would range from 2 to 18 feet in height, with the smaller trees being planted on the slope areas and the larger trees being planted on flatter areas.

There would likely be planting limitations on the proposed cut slopes. Excavations in excess of 20 feet are expected to expose the native stone, thereby eliminating a soil layer for planting. Accordingly, the preliminary planting plans illustrate those areas where less than 20 feet of excavation would occur and would allow trees to be planted upon the slope.

### ***Preferred Alternative***

In addition to the plant materials, the design for the Preferred Alternative includes several additional features:

Sidewalks. The existing sidewalk in front of the Green Park Inn is within a planned construction easement. It would be restored as a hard landscape element to provide visual separation from US 321 and the Green Park Inn and to serve as a functional accessory for patrons of the Green Park Inn. Sidewalks would be built on the east side of US 321 (golf course side) from the Green Park Inn to US 321 Business. New sidewalks would be built on both sides of the alignment from US 321 Business to the Shoppes on the Parkway. The sidewalks would tie into existing or planned sidewalk expansion by the Town of Blowing Rock, particularly at the intersection of US 321/US 221.

Street Lights. During the development of final landscape plans, decorative pedestrian lights would be included at select locations along the entire project.

Reconstructed/Constructed Native Stone Walls. NCDOT will replace all existing stone walls within the Town limits removed by the project with new in-kind stone walls.

At the suggestion of one citizen, the feasibility of a pedestrian bridge (overpass) at Sunset Drive was considered. After analyzing the requirements for construction, it was determined that the right-of-way needed would have too great an impact on the existing character of the intersection physically and visually.

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### ***Bypass Alternatives***

Landscape treatments would include cut and fill slope planting along the entire length of all alignments, including the neighborhoods through which these alternatives would pass. Treatments for Bypass Alternatives 1A and 1B would differ in that Bypass Alternative 1A would require landscaping of a major fill east of Gideon Ridge and Bypass Alternative 1B would require a deep cut at Gideon Ridge that would require landscaping along both sides of the alignment.

The Bypass Alternatives 4A and 4B corridor is primarily rural in nature and would require extensive cut and fills along its length. Landscape treatments would be used to lessen the visual impact of a new road in this area, including impacts to views from the Blue Ridge Parkway. Bypass Alternative 4B would require less landscaping because its design includes more bridges, which reduces the total number of cuts and fills.

## **2.4.5 Permits Required**

A USACE Section 404 permit would be required under 33 CFR Part 323 for discharges of dredged or fill material into Waters of the United States for any of the Build Alternatives. The Clean Water Act provides for public notice and review of Section 404 permit applications, as well as review by the US Fish and Wildlife Service and approval by the US Environmental Protection Agency (EPA). Projects in trout waters require review by the NC Wildlife Resources Commission (NCWRC). Additionally, an EPA National Pollutant Discharge Elimination System permit for stormwater discharge would be required under 40 CFR Part 122.

A Water Quality Certification pursuant to Section 401 of the Clean Water Act would be needed from the North Carolina Department of Environment and Natural Resources (DENR), Division of Water Quality. This permit is required in association with the USACE Section 404 permitting process.

Finally, a sedimentation and erosion control permit would be required from DENR. A local blasting permit would be required from the Town of Blowing Rock.